Canton Odor Complaint Investigation

ATAST Investigation Number: 06011

May 2-24, 2006

NC Division of Air Quality

Toxics Protection Branch

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ACRONYMS

AEGL – Acute Exposure Guide Line
AQL - Air Quality Laboratory of the Toxics Protection Branch
ARO - Asheville Regional Office
ASTM - American Society for Testing and Materials
ATAST - Air Toxics Analytical Support Team
ATSDR – Agency for Toxic Substances and Disease Registry
BLQL - Below Lower Quantitation Limits
BRPP - Blue Ridge Paper Products, Inc.
CA OEHHA – California Office Environmental Health Hazard Assessment
CVAFS – Cold Vapor Atomic Fluorescence Spectrometer
COC - Chain of Custody
COPC – Chemical of Potential Concern
CRL – Comparative Risk Level
DAQ - Division of Air Quality
DNPH - Dinitrophenylhydrazine
EPA - Environmental Protection Agency
ERPG – Emergency Response Planning Guide
GC/MS - Gas Chromatography Mass Spectroscopy
GC/SCD – Gas Chromatography Sulfur Chemiluminescence Detector
HPLC - High Performance Liquid Chromatography
HI – Hazard Index
HQ – Hazard Quotient
IUR – Inhalation Unit Risk
IRIS – Integrated Risk Information System
KCl – Potassium chloride
L – Liter
LC – Liquid Chromatography
LDL – Lower Detection Limit
LQL - Lower Quantitation Limit
m^3 - Cubic meter
mL - Milliliter (10^{-3} Liters)
µg - Microgram (10^{-6} grams)
mg - Milligram (10^{-3} grams)
MRL - Minimum Reporting Limit
MTBE – Methyl tertiary butyl ether
NC AAL - North Carolina Acceptable Ambient Level
NCASI - National Council for Air and Stream Improvement
ng - Nanogram (10^{-9} grams)
NIST - National Institute of Standards and Technology
PBM – Particulate bound mercury
pg - Picogram (10^{-12} grams)
ppb - Parts per billion
ppbv - Parts per billion by volume
ppm - Parts per million
QA/QC - Quality Assurance/Quality Control
QAM - Quality Assurance Manager

QAPP – Quality Assurance Project Plan
RfC – Reference Concentration
RGM - Reactive Gaseous Mercury
RSC - Reduced Sulfur Compound
RSD - Relative Standard Deviation
SOP - Standard Operating Procedure
SUMMA - is an electro-polishing process by which the interior of a stainless steel container is passivated.
TGM - Total Gaseous Mercury
TPB - Toxics Protection Branch
TO-11A - US EPA's Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC)
TO-15 - US EPA's Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Determination of VOCs in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography / Mass Spectroscopy (GC/MS)
TOSHI – Target Organ Specific Hazard Index
TRS - Total Reduced Sulfur
UAT - Urban Air Toxics Network
UV - Ultraviolet
VOC - Volatile Organic Compound
WWTP - Waste Water Treatment Plant

Executive Summary

In November 2005, in response to documented complaints received from Canton, NC citizens alleging unpleasant odors from Blue Ridge Paper Products facility (BRPP), NC Division of Air Quality Asheville Regional Office (DAQ, ARO) requested that the DAQ Toxics Protection Branch (TPB) undertake a study to evaluate odor and air quality in Canton. After subsequent discussions with BRPP and regional office staff, the TPB designed and conducted a study May 3-24, 2006.

The goals of this study were to: 1) identify and quantitate air contaminants having the potential to contribute to the level of odor in Canton, 2) identify and quantitate air contaminants believed to cause adverse human health effects, and 3) estimate the potential levels of risk of exposure to these air contaminants. This report addresses those goals.

The compound**s** or compound classes thought to contribute to odor and air quality problems in Canton were ammonia, carbonyl compounds, volatile organic compounds, reduced sulfur compounds.

Three sites were selected for this study. Site A was located in Asheville, NC on the campus of Asheville Buncombe Technical Community College (ABTech). This site also serves as an Urban Air Toxics network (UAT) monitoring site. Sites B and C were located in Canton, NC and represented the best available sites in Canton in terms of predominant wind directions, proximity to the facility, proximity to the home and business of the primary complainant, and for logistics considerations.

This is the report of a 21-day air quality study in and around Canton, NC. The users of this report are advised that it is not known if the airborne concentrations measured in this study are representative of annual airborne concentrations in this region of North Carolina. Therefore, the results of the risk assessment of these data may or may not represent exposure risk over a long period of time. In addition, airborne concentration measurements made by integrated sampling over 24-hour periods were adjusted so that comparisons could be attempted on the basis of acute exposure. These data adjustments represent a worst-case situation, and are not thought to be representative of actual acute exposures. It is more probable that acute exposure concentration lies somewhere between the 24-hour exposure measurement and the acute adjusted value. Caution should be used in drawing any conclusions about acute and chronic exposure from these data.

Ammonia sampling was conducted at all three sites using a chemically treated paper tape monitor. Due to intermittent problems with the data loggers and several power interruptions, the data collected did not meet the minimum TPB data quality objective (DQO) for completeness of 75% for investigative studies. As a result, no extensive data analysis for ammonia was conducted; however it is important to note that no data collected exceeded the lower detection limit (LDL) of 2.6 ppm (1820 $\mu g/m^3$). These data indicate that there was no risk from acute exposure to ammonia (NC acceptable ambient level (AAL) = 2700 $\mu g/m^3$). There is no chronic NC AAL for ammonia, but there is an EPA Reference Concentration (RfC) (100 $\mu g/m^3$). Because of the relatively high LDL for this sampling method, it cannot be concluded that there is no risk resulting from chronic exposure. Ammonia is not carcinogenic; there is no cancer risk.

Using an EPA Compendium Method, carbonyl sampling was conducted at Sites A, B, and C for formaldehyde, acetaldehyde, acetone, butyraldehyde, benzaldehyde, valeraldehyde, hexanaldehyde, propionaldehyde, crotonaldehyde, acrolein, isovaleraldehyde, three tolualdehyde isomers, and 2,4 dimethylbenzaldehyde. Acrolein was eliminated from data analysis because EPA has invalidated the sampling portion of the compendium method for this compound. Crotonaldehyde, o-tolualdehyde, and 2,4-dimethylbenzaldehyde were eliminated from data analysis because sample analysis indicated that none of the airborne concentrations were above their individual LDL and there are no NC AALs for these compounds. Formaldehyde and acetaldehyde had the highest average concentration of carbonyl compounds monitored in the study area. Additionally, comparison of carbonyl data for Sites A, B, and C with that collected during the month of May in each of the years from 2002 to 2005 at the rural Candor, NC UAT site (located in south central NC approximately 65 miles due east of Charlotte, NC) shows that carbonyl data collected at Sites A, B, and C are comparable to levels found in the rural air of Candor. The following table compares equivalent 1-hour carbonyl concentrations with the applicable NC AAL:

ACUTE EFFECTS	**Equivalent 1-hr Concentration, μg/m^3 (NC AAL basis: acute 1-hr exposure)**			
Carbonyls	**Site A**	**Site B**	**Site C**	**NC AAL**
Formaldehyde	128	644	85	150
Acetaldehyde	40	101	33	27000

There are no chronic or cancer NC AALs for carbonyls.

Volatile organic compound (VOC) sampling was also conducted at Sites A, B, and C. Samples were analyzed using EPA Compendium Method TO-15 for a suite of 45 compounds. Comparison of data from each of the three sites indicates that average VOC concentrations across sites are similar. Additionally, the comparison of Sites A, B, and C to the rural Candor UAT site (data for May in both 2005 and 2006) indicates that VOC concentrations are elevated in those VOCs such as benzene, toluene, and xylenes, that are emitted by mobile sources that tend to be concentrated in urban areas. The following table compares VOC concentrations with an applicable NC AAL:

ACUTE EFFECTS	**Equivalent 1-hr Concentration, μg/m^3 (NC AAL basis: acute 1-hr exposure)**			
VOCs	**Site A**	**Site B**	**Site C**	**NC AAL**
1,1,1-Trichloroethane	0.55	13.1	13.1	2.4×10^5
Benzyl chloride	11.1	0.46	11.0	500
Dichloromethane	27.2	8.9	8.3	1700
Freon-113	0.77	18.4	18.4	9.5×10^5
Xylenes*	36.4	23.8	25.3	6.5×10^4
Methyl isobutyl ketone	28.1	33.4	25.8	3×10^4

* maximum concentration of o-, m-, or p-xylene

CHRONIC EFFECTS	**24-hr Concentration, μg/m^3 (NC AAL basis: chronic 24-hr exposure)**			
VOCs	**Site A**	**Site B**	**Site C**	**NC AAL**
1,1,1-Trichloroethane	0.55	0.55	0.55	1.2×10^4
Carbon disulfide	0.37	0.43	0.37	186
Chlorobenzene	0.46	0.46	0.68	2200
Freon-12	3.2	3.2	3.0	2.5×10^5
Xylenes*	1.52	0.99	1.05	2700
Methyl isobutyl ketone	0.41	0.41	0.41	2560
n-Hexane	0.42	0.39	0.40	1100
Toluene	2.87	1.78	1.72	4700

* maximum concentration of o-, m-, or p-xylene

CANCER EFFECTS	Annual Concentration, µg/m³ (NC AAL basis: annual exposure)			
VOCs	**Site A**	**Site B**	**Site C**	**NC AAL**
1, 3-Butadiene*	0.22	0.22	0.22	0.17
1,1,2,2-Tetrachloroethane	0.69	0.69	0.69	6.3
Benzene*	1.04	1.07	1.16	0.12
Carbon tetrachloride	0.63	0.63	0.63	6.7
Chloroform	0.49	0.55	0.49	4.3
Dichloromethane	0.45	0.37	0.35	24
Tetrachloroethylene	0.68	0.68	0.68	190
Trichloroethylene	0.54	0.54	0.54	590
Vinyl chloride	0.26	0.26	0.26	0.38

* annualized concentration exceeds NC AAL.

Data from the 1999 National Air Toxics Assessment ((NATA), see http://www.epa.gov/ttn/atw/nata1999/) for Hayward County, NC indicate airborne concentrations of benzene and 1,3-butadiene are 0.76 and 0.029µg/m³, respectively.

Mercury monitoring was conducted at Sites A and C. No monitoring was conducted at Site B because the site was found to have been the site of a prior mercury spill. Total gaseous mercury (TGM) sampling at Site A was performed from April 30 - May 20, 2006. The average measured concentration at Site A was 1.3 ng/m³ (nanograms/cubic meter or one billionth of a gram per cubic meter of air sampled). TGM is the sum of the elemental mercury ($Hg^{(0)}$) and reactive gaseous mercury (RGM); however, because historical sampling data indicates that RGM is typically 3 orders of magnitude lower than the concentration of $Hg^{(0)}$, for practical purposes TGM is equal to $Hg^{(0)}$. Monitoring for $Hg^{(0)}$ at Site C was performed from May 1–24, 2006. The average concentration was 1.6 ng/m³. Additionally at Site C, RGM and particulate bound mercury (PBM) sampling were performed from May 12-22, 2006. The average particulate concentration was 0.44 pg/m³ (picograms per cubic meter or one trillionth of a gram per cubic meter). The average RGM concentration was 0.78 pg/m³. The average for the RGM was actually below the method detection limit (MDL) of 0.82 pg/m³. Of the RGM samples collected, the maximum concentration was 7.8 pg/m³. It is a generally accepted rule of thumb that the average background $Hg^{(0)}$ concentration is between 1 and 2 ng/m³. Sampling data collected at Sites A and C are within this range and therefore are not considered to be different from background. For comparison purposes, the most stringent NC AAL for mercury or compounds of mercury is 600 ng/m³.

Reduced sulfur compound monitoring was conducted at Sites A, B, and C and the samples were analyzed for a suite of 20 reduced sulfur compounds (RSC). RSCs as a class of compounds are generally malodorous, however they are not the only chemicals that are. Only 4 samples (one at Site A, one at Site B, and two at Site C) of the 38 samples collected produced detectable results. RSCs generally have low odor threshold concentrations (the human sense of smell is very sensitive)**;** these compounds can be detected by their odor even when their airborne concentrations are so low that they cannot be analytically detected. Only carbonyl sulfide, carbon disulfide, ethyl methyl sulfide, and diethyl sulfide have olfactory thresholds greater than the detection limits for the monitoring method. Otherwise unidentified TRS compounds can produce an unpleasant olfactory response, but RSCs are not the only compounds that produce such a response. Additionally, of the samples with detectable levels of RSCs, 1 sample from Site A contained one quantifiable compound, diethyl disulfide, at 11.0 ppbv (parts per billion by volume). The other three samples contained nonspecific total reduced sulfur (TRS, defined as any reduced sulfur compound(s) not specifically identified and quantified relative to hydrogen sulfide response) at Site A of 220 ppbv, at Site B of 58 ppbv, and Site C of 12 ppbv and 16 ppbv.

A risk assessment was performed using the acquired data to examine the potential impact(s) on human health. Both acute exposure impacts and chronic exposure impacts were considered. Since a large percentage of data were collected as 24-hour integrated samples, and since acute exposure occurs over a brief time period (e.g., 1-hour), a method was developed to produce an "equivalent 1-hour exposure concentration" from the 24-hour data. This derived exposure concentration represents a "worst case" condition of exposure. While acknowledging that this is an artificial construct, it does provide a dataset that can be examined for acute health impacts. Hazard Quotients (HQs) were determined for both the "equivalent 1-hour" and 24-hour average exposure concentrations by dividing the exposure concentration by a Comparative Risk Level (CRL), a peer-reviewed health-based benchmark. Hazard Indexes (HIs) were determined by summing the HQs for each pollutant type (VOCs, carbonyl compounds, RSCs, ammonia, and mercury), if appropriate. For each HQ > 1, a Target Organ Specific Hazard Index (TOSHI) was determined to identify organs or organ systems impacted. In addition, cancer risk was evaluated for those compounds that are carcinogenic. A detailed discussion of risk evaluation and these calculations is found in Section 8 of this report.

At Site A (Asheville), there are no apparent non-cancer health impacts from VOC exposure. Benzene exposure increases cancer risk to approximately 2 cases per million. This means that exposure to the average benzene concentration as determined in this study over a 70-year life might result in 2 additional cases of cancer per million population. These additional cases are called excess risk. The higher the excess risk, the more concern there should be about exposure. Eleven other VOCs have elevated cancer risk, but since the LDLs for these compounds are high (compared to the health-based benchmark), the product of (½LDL) and the inhalation unit of risk (IUR) yields cancer risk > 1 per million. These eleven VOCs should be classified as "inconclusive" risk drivers. For carbonyl compounds, the "worst case" acute HI = 67; the "best case" HI = 2.8. The major acute risk driver is formaldehyde. The chronic HI is 0.73; there does not appear to be any excess chronic exposure risk. Cancer drivers are acetaldehyde (excess risk = 4 cases per million) and formaldehyde (excess risk = 69 cases per million). For RSCs, the "worst case" acute HI = 3; the "best case" HI < 1. The risk driver is methyl mercaptan. The chronic HI = 2; the risk driver is hydrogen sulfide. There appears to be no excess cancer risk. Neither ammonia nor mercury exposure appear to pose acute, chronic, or cancer health impacts. A TOSHI analysis indicates that RSCs impact the neurological system (65% of the TOSHI).

At Site B (Blue Ridge), there are no apparent non-cancer health impacts from VOC exposure. Benzene exposure increases cancer risk to approximately 2 cases per million, and chloroform exposure increases cancer risk to 13 cases per million. For carbonyl compounds, the "worst case" acute HI = 260; the "best case" HI = 11. The risk driver is formaldehyde. The chronic HI = 3; risk drivers are formaldehyde and acetaldehyde. The cancer driver is formaldehyde (excess risk = 349 cases per million). For RSCs, the "worst case" acute HI = 4; the "best case" HI < 1. The risk driver is methyl mercaptan. The chronic HI = 2; the risk driver is hydrogen sulfide. There appears to be no excess cancer risk. Neither ammonia nor mercury exposure appear to pose acute, chronic, or cancer health impacts. A TOSHI analysis indicates that RSCs impact the neurological system (40% of the TOSHI), and carbonyl compounds impact the respiratory system (57% of the TOSHI).

At Site C (Canton), there are no apparent non-cancer health impacts from VOC exposure. Benzene exposure increases cancer risk to approximately 3 cases per million. Eleven other VOCs have elevated cancer risk associated with exposure, but since the LDLs for these compounds are high, the product of (½ LDL) and the IUR yields cancer risk > 1 per million. These eleven VOCs should be classified as “inconclusive” cancer risk drivers. For carbonyl compounds, the “worst case” acute HI = 42; the “best case” HI = 2.2. The risk driver is formaldehyde. The chronic HI is 0.5; no excess chronic risk is indicated. Cancer drivers are acetaldehyde (excess risk = 3 cases per million) and formaldehyde (excess risk = 46 cases per million). For RSCs, the “worst case” acute HI = 3; the “best case” HI < 1. The risk driver is methyl mercaptan. The chronic HI = 2; the risk driver is hydrogen sulfide. There appears to be no excess cancer risk. Neither ammonia nor mercury exposure appear to pose acute, chronic, or cancer health impacts. A TOSHI analysis indicates that there are no overall impacts on any organ or organ system (TOSHI < 1).

1.0 INTRODUCTION

In November 2005, in response to documented complaints received from Canton, NC citizens concerning odors from Blue Ridge Paper Products facility (BRPP), the Asheville Regional Office (ARO) requested that the Toxics Protection Branch (TPB) of the Division of Air Quality (DAQ) undertake a study to evaluate odor and air quality in Canton. After subsequent discussions with BRPP and regional office staff, TPB designed and conducted the study in May 2006, the results of which are presented in this report.

1.1 Background

BRPP is a pulp and paper mill that has operated continuously at its current location in Canton since 1905 under various company names. BRPP dominates the local environment and economy, employing a significant portion of the population from the town and surrounding area.

At the time of this study, two small industries, Coastal Lamp Manufacturing (a small lamp factory) and Arrow Wood Products (a custom wood furniture shop) operated in the immediate vicinity of the study area. The rest of the study area consisted of residences, apartment houses, churches, shops and service industries such as “fast food” restaurants. The main complainant lives due east of BRPP. There can be considerable mobile source emissions due to BRPP employee shift changes, other vehicular traffic on the main traffic corridors surrounding BRPP, and regular rail traffic.

Dispersion of air contaminants in the Canton area is heavily influenced by topography. Canton lies in a valley surrounded by mountainous terrain. Poor meteorological conditions can exist in mountainous terrain preventing effective air dispersion and can trap or concentrate contaminants closer to ground level. Meteorology, topography, mobile sources, and BRPP emissions are contributing factors influencing air quality in Canton.

The BRPP facility is a large, integrated, bleached Kraft process pulp and paper mill with separate pine and hardwood pulp fiber production lines. Each fiber line includes batch digesters, washers, and oxygen delignification systems. There are two pulping chemical recovery furnaces with associated pulping liquid evaporators and two lime kilns to recycle pulping chemicals.

Separate hardwood and pine pulp bleach lines and a chlorine dioxide generation plant comprise the bleaching area. Four coal-fired boilers and a wood waste/bark/coal-fired bark boiler provide process steam.

Purchased wood chips are cooked with Kraft process pulping chemicals such as sodium hydroxide and sodium sulfide in batches inside steam heated pressure cookers or digesters to loosen and separate the cellulose fibers. These fibers are then washed to remove the pulping chemicals. The resulting brown wood pulp is treated with oxygen to lighten its color and finally bleached to white paper pulp in the bleaching area. The bleached pine and hardwood pulps are then made into paper on three paper machines and one paper board machine.

Odorous air pollutant emissions from this facility are typically constituents identified as reduced sulfur compounds (including hydrogen sulfide, dimethyl disulfide, and dimethyl sulfide and methyl mercaptan), acetaldehyde, creosol, formaldehyde, hydrogen chloride, ammonia, and sulfuric acid.

The majority of the reduced sulfur compounds are typically emitted from the pulp production and chemical recovery systems and the BRPP wastewater treatment system. Organic compounds, sulfuric acid, and hydrochloric acid are emitted from coal and wood waste combustion in the power boilers and from combustion of pulping residue in the chemical recovery furnaces. The boilers and furnaces are equipped with electrostatic precipitators for particulate reduction. There are foul gases and foul condensate collection systems installed on the pulp production systems to reduce emissions. Collected foul gases are passed through condensers to remove moisture and then burned in the lime kilns. Foul condensate is collected and steam stripped prior to discharge to the wastewater treatment plant (WWTP). Stripper off-gas is ducted to lime kilns for burning.

The majority of odorous compounds present in the foul condensate are normally reduced by 95%-99% by means of steam stripping prior to treatment in the WWTP.

BRPP informed DAQ in late 2005 that an annual maintenance downtime for the steam stripper was scheduled for May 15, 2006 during which no foul condensate stripping would occur. The planned outage was scheduled for a minimum of four (4) days. To minimize the potential for odorous emissions from the WWTP during the stripper outage, BRPP also planned inspection outages for the pine fiber line (digesters, washers and associated systems) and one of the plant's two pulping chemical recovery furnaces. This was expected to reduce the total amount of unstripped foul condensate going to the WWTP by 50%-60%.

Unlike the wastewater treatment lagoons used at other pulp and paper plants in North Carolina, BRPP uses an activated sludge system to manage wastewater. The industrial activated sludge-type wastewater treatment plant is susceptible to adverse effects from sudden increases in incoming chemical loading that can typically occur when the steam stripper is not operated to remove those compounds. While the amount of foul condensate produced during the maintenance period was to be minimized by a concomitant shut down of the pine fiber line, the potential for increased odor remained a possibility because the steam stripper would be off-line.

1.2 Study Design

In preparation for the development of a study design to evaluate odor and air quality in Canton, in December 2005 TPB met with ARO staff, representatives from NCASI (National Council for Air and Stream Improvement) and BRPP in Canton to discuss an earlier odor study commissioned by BRPP. The BRPP study concluded that the majority of odorous emissions from BRPP were emitted from the wastewater collection sewer, and that the main emission point was the wet well, from which the sewage was pumped across the Pigeon River to the BRPP WWTP.

In conjunction with ARO, TPB developed a study to monitor air quality. Assuming that emissions from other sources were unchanging, and based on process engineering principles, it was expected that there would be periods of elevated exposure to air contaminants to the local population during the planned maintenance period.

The goals of this study were to: 1) identify and quantitate air contaminants having the potential to contribute to the level of odor in Canton, 2) identify and quantitate air contaminants believed to cause adverse human health effects, and 3) estimate the potential levels of risk of exposure to these air contaminants. This report addresses Objectives 1 and 2 listed above. Objective 3 will be addressed in a separate report.

1.2.1 Monitoring Activities

The air monitoring plan (see Appendix A) was devised based on these goals and objectives, previous discussions, background research on air emissions from BRPP, the TPB monitoring protocol for urban areas, and the capacity and capabilities of TPB.

The sampling plan was devised to collect samples as either a composite 24-hr sample or on a fixed-time interval basis depending on the compound being sampled. The following table outlines groups of monitored compounds, the sampling media used, the sample collection time interval and the collection location(s). Meteorological data were collected concurrent with sampling using instrumentation mounted on 10-meter towers.

Table 1.1 Compounds of Interest General Sampling Information

Compound(s) of Interest	Sampling Media	Time Interval	Site(s)
Ammonia	Chemical tape meter	20 sec 60 sec	A, B C
Carbonyls	DNPH cartridges	24 hr	A, B, C
Volatile Organic Compounds	SUMMA canisters	24 hr	A, B, C
Elemental Mercury Reactive Gaseous Mercury	Continuous Continuous	5 min 1 hr	A, C C
Reduced Sulfur Compounds	SilcoSteel® Canisters	24 hr	A, B, C

1.2.2 Sampling Sites

Canton, NC is located approximately 20 miles to the west-southwest of Asheville, NC. The sampling plan designated monitoring at three sites. One of the sampling sites was located in Asheville, NC on the campus of the Asheville Buncombe Technical Community College approximately 1 mile south of downtown Asheville and is designated Site A as shown in Figure 1.1. The longitude and latitude for the site are: N35º 34’ 20”, W82º 33’ 32” at an elevation is 2110 feet above sea level. Northwest and adjacent to the site is a steep embankment that drops approximately 45-50 feet to a parking lot and maintenance shop. The maintenance shop is approximately 200 horizontal feet from Site A. South is a 0.7-acre tar and gravel parking lot. A utility building is located about 260 feet to the south. Approximately 1100 feet to the west and 200 feet lower are railroad tracks that run parallel to the French Broad River. There are several residences to the east and northeast approximately 200 feet away. The Student Union and classroom buildings for the college are located approximately 1000 feet to the southeast. Site A was chosen as a comparison site having similar weather, topography, and is an existing Urban Air Toxics (UAT) network monitoring site. The use of an existing UAT site could provide historical and longer-term comparison data for volatile organic compounds (VOCs) and carbonyls.

Sites B and C were located in Canton, NC as shown in Figure 1.2. Sites B and C represented the best available sites in Canton in terms of predominant wind directions, proximity to the facility, proximity to the home and business of the primary complainant, and logistic considerations.

Site B is located at the center of a BRPP employee parking lot located just east of the plant, in a small metal building formerly used by BRPP for environmental monitoring. Adjacent to the metal building is a permanently installed antenna tower. The parking lot is paved and up to two thirds of the lot is routinely occupied by BRPP personnel. The longitude and latitude for Site B are: N35º 31’ 43”, W82º 50’ 03” at an elevation is 2600 feet above sea level.

Site B is bordered by the Norfolk Southern Railroad track to the south. The track is below grade by approximately 40 feet. The tracks to the Canton railroad yard begin at this location and extend west of the Bridge Street Overpass southerly along BRPP. Bridge Street borders site B to the west. Bridge Street crosses the NS Railroad and is approximately 40 feet higher in elevation than BRPP. Newfound Road bounds the north side of Site B and rises steeply eastward. Several apartment houses and a church are located north, across Newfound Road. The east side of Site B is blocked by a vertical hillside of about 30 feet, on which are single residences.

Site C is located in the center of a large employee parking lot south of BRPP in downtown Canton. The longitude and latitude for Site C are: N35º 32’ 7”, W82º 49’ 57” at an elevation is

2575 feet above sea level. Generally, the lot is of limited use and activity and is predominately used as a municipal resource. To the east are Adams Street and the Town of Canton Municipal Building and the Fire Department. To the north is located a Norfolk Southern Railroad yard and tracks. The railroad conducts switching operations 24 hours a day, mainly during daytime hours. To the south is Park Street (US Highway 19/23) and to the west is a commercial laundry and its parking lot. The Pigeon River runs between this parking lot and the parking lot in which Site C is located. Site C was proximate to the BRPP WWTP, which was identified in a BRPP odor study as the primary source of odors from BRPP.

Additional site photos are located in Appendix B.

Figure 1.1 Site A in Asheville, NC

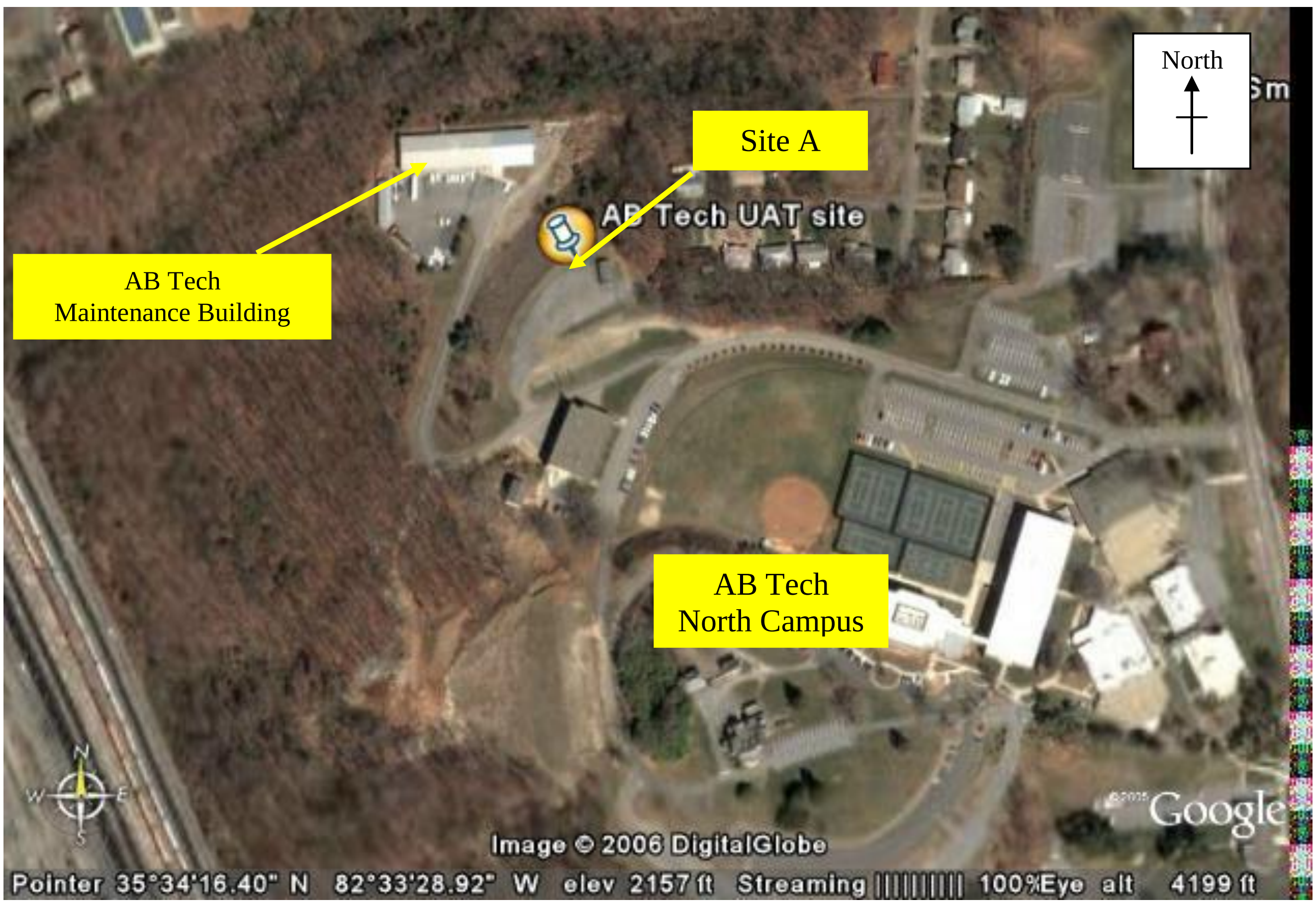
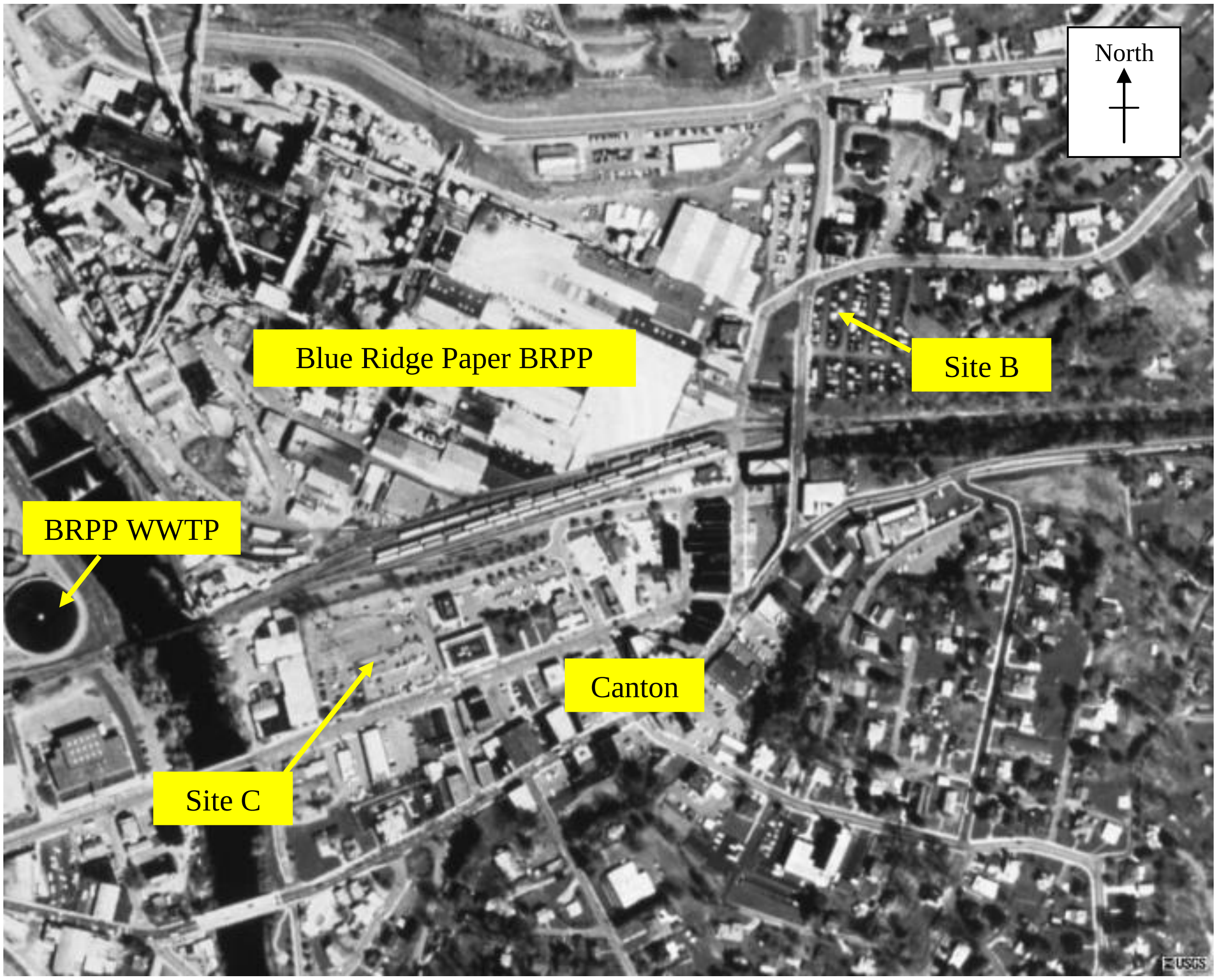


Figure 1.2 Sites B and C in Canton, NC



1.2.3 Sampling Study Chronology

During the month of May 2006, BRPP performed a one-week maintenance outage. It involved the pine fiber line, recovery furnace #10 and the foul condensate stripper. The foul condensate stripper was shut down for cleaning, maintenance and inspection. During normal operation, the stripped foul condensate gases are incinerated in the limekilns. The excess foul condensates not stripped are sewered for treatment. The stripped or clean condensates are returned to process. During an outage, the foul condensates were sewered to the activated sludge WWTP. Based on previous experience, the maintenance outage period is when the greatest frequency of odor complaints are reported.

The air monitoring study began on May 3, 2006 and was completed on May 24, 2006. The first week of air monitoring covered the pre-outage period; the next two weeks covered the outage period; and the last week covered the restart period.

Specific timeline activities were as follows:

<u>Pre-Outage</u> May 1 - 7, 2006

- May 1 - 5 – TPB mobilized in Canton, NC to set up ambient monitoring equipment at Sites A, B and C.
- May 3 - 7 – TPB initiated ambient air sampling as each site was brought online.

<u>Outage</u> May 8 - 20, 2006

- May 8 - 11 - Normal operations. TPB continued routine daily collection of ambient air samples. Samples included carbonyls, reduced sulfur compounds (RSCs), volatile organic compounds (VOCs), and did continuous monitoring for elemental and reactive gaseous mercury.
- May 12 - 3 pm - BRPP began purge of pine accumulator, diluted foul condensates sewered at flow rate of approximately 200 gallons per minute.
- May 14 - 7 pm, accumulator purge completed, pine fiber line was taken off line, "spring outage" began

  -10 pm, recovery furnace #10 went off line and the liquor recovery process outage began.
- May 15 - 7:30 am, foul condensate stripper outage began, all hardwood fiber line foul condensates were sewered, 24-hour steam purge of foul condensate stripper began, # 4 kiln brought down for annual maintenance.
- May 16 - 7 am, foul condensate stripper purge completed, stripper vessel opened for annual internal inspection and maintenance.
- May 18 - outage work on foul condensate stripper completed, mill water and steam are applied to test and warm-up stripper column.

- May 19 - 8 am, foul condensates recharged into foul condensate stripper, stripper outage ended
  - 2 pm, recovery furnace #10 cold startup on No. 6 fuel oil began
  - 9 pm - pine fiber line was restarted
  - 11 pm – recovery furnace #10 on liquor, recovery outage ended.
- May 20 – spring outage completed, BRPP completed startup of pine fiber line and adjusted flow balance in the foul condensate stripper for normal mill operations, #4 kiln placed back in service.

Post-Outage May 20 - 24, 2006

- May 21- normal operations resumed with greater than 95 percent of foul condensates stripped, WWTP completed processing of foul condensates sewered during outage.
- May 23 - TPB collected last ambient air samples (last sample period ended about 9 am on May 24).
- May 24 - TPB decommissioned the sampling sites and departed Canton.

1.2.4 Quality Assurance/Quality Control

The Quality Assurance Project Plan (QAPP) developed for the UAT network was followed for all 24-hour integrated sampling including carbonyl compounds, RSCs and VOCs. Standard operation procedures (SOPs) were followed for mercury sampling. These SOPs include QA/QC activities. The TPB QAPP procedures for meteorological data were followed. The calibration of the Zellweger Single Point Monitors (SPMs) was checked in accordance with the manufacturer SOP.

2.0 METEOROLOGICAL DATA

Each site was initially equipped with a meteorological station that recorded data at 5-minute intervals at a height of 10 meters for wind speed, wind direction, wind direction standard deviation, temperature, and relative humidity. During the study, the sensor heads malfunctioned intermittently at each site, which necessitated the use of meteorological data from 10-meter proximate sites when necessary.

Meteorological data are used to produce wind roses, which are a graphical representation of the wind speed and direction on a polar plot. For most work done by the TPB, the wind directions are plotted as the direction "from which" the wind is blowing towards the site.

The data used to produce the wind rose for each sampling period at Site A was obtained from the UAT meteorological station co-located at Site A. These data are in 15-minute average increments.

Data used to produce the wind roses for Sites B and C from May 1-19, 2006 were obtained from the meteorological station at Site C. Despite all efforts to make the Site B meteorological station operational, it was not made completely operational during the sampling period and therefore it was decided to use Site C data for both Sites B and C. Due to the length of the sampling time for most samples (24-hours), it was thought that differences associated with micrometeorology would be minimal. The remainder of the wind roses for Sites B and C from May 19-24 were constructed from 10-meter tower data obtained from the BRPP meteorological station located just west of the facility. This site was proximate to Sites B and C. The data averaging time was 1-hour. The wind roses will be used throughout the results discussion sections by reference to this section.

Figure 2.1

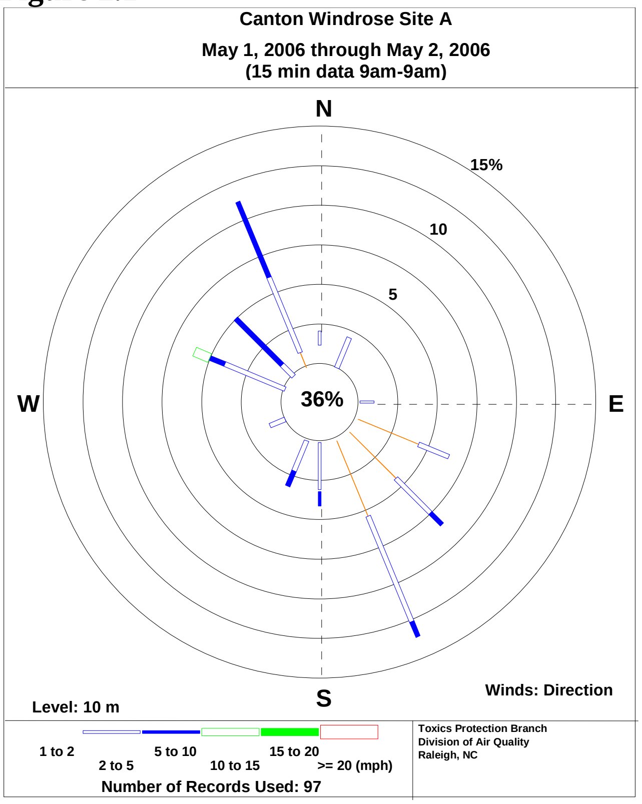
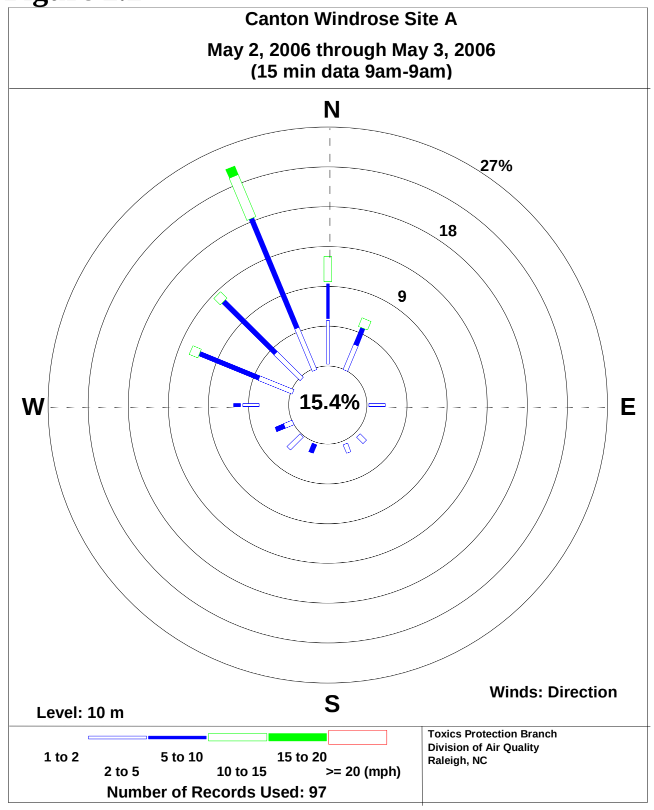


Figure 2.2



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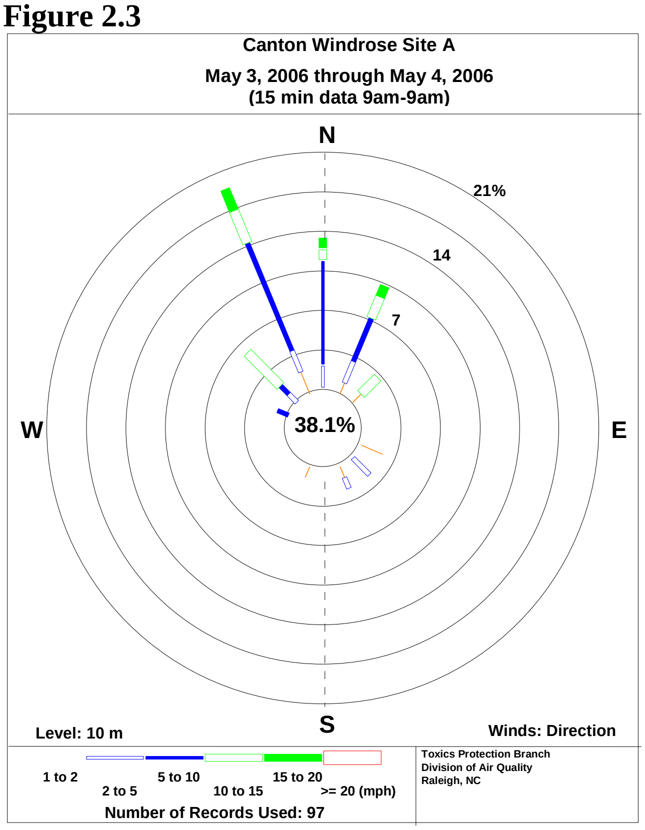

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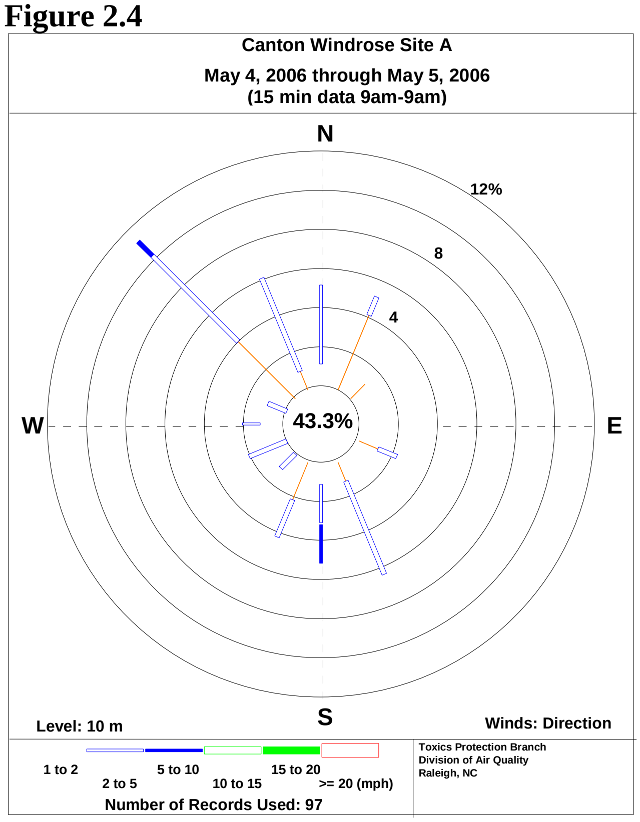

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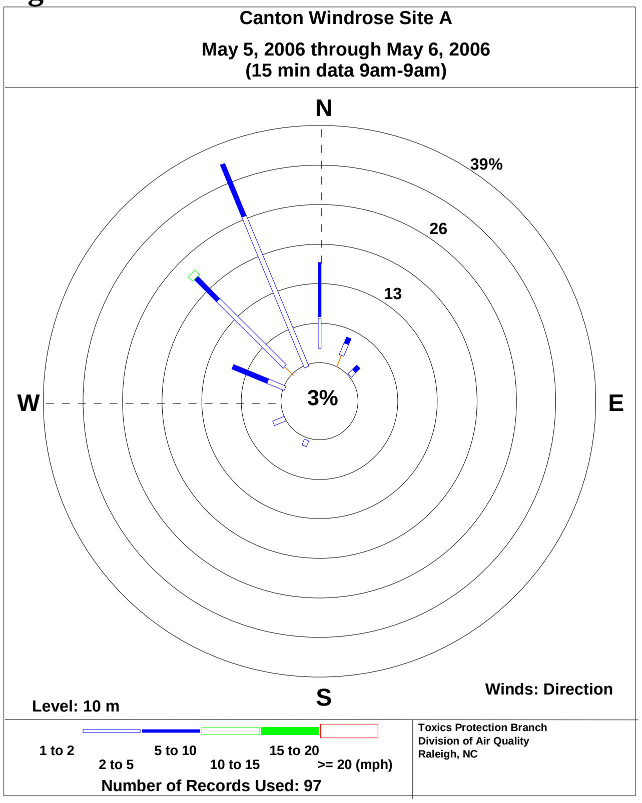

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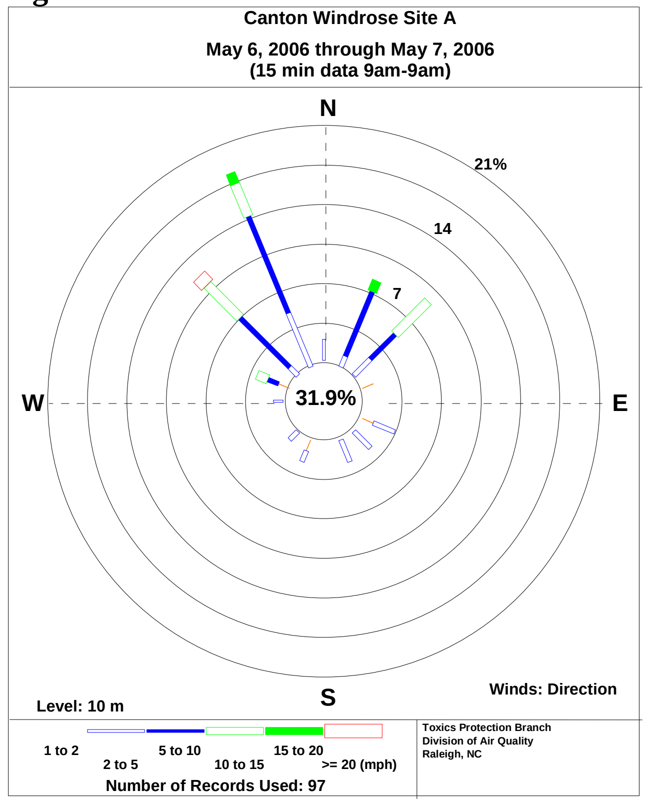

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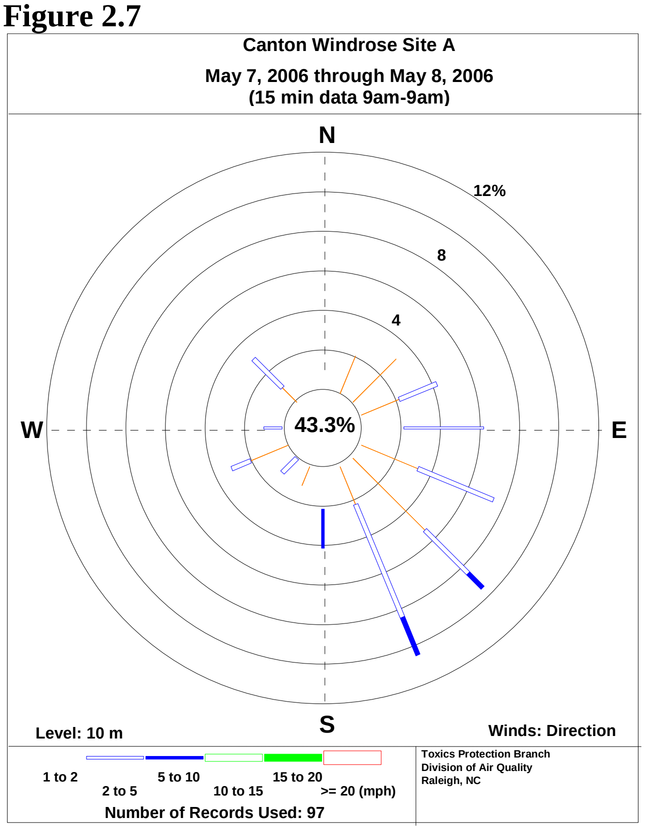

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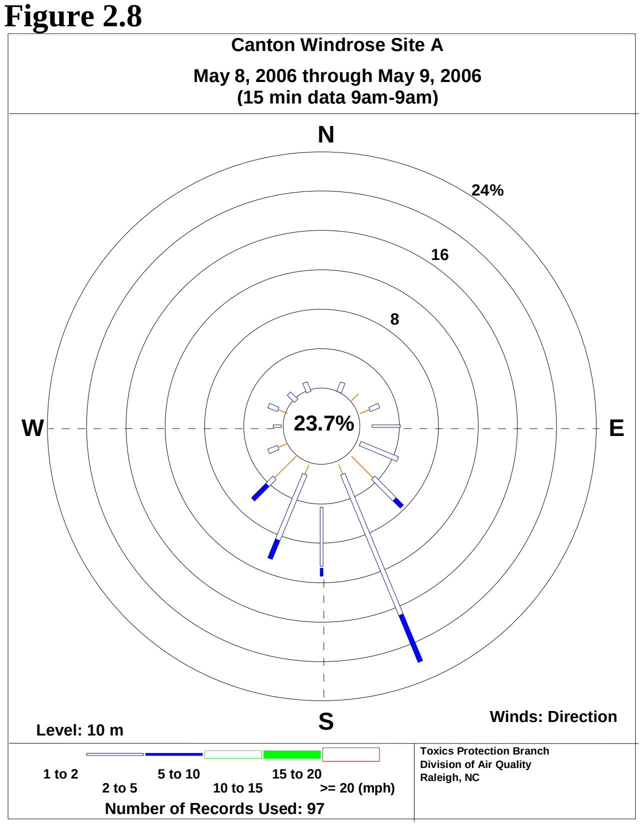

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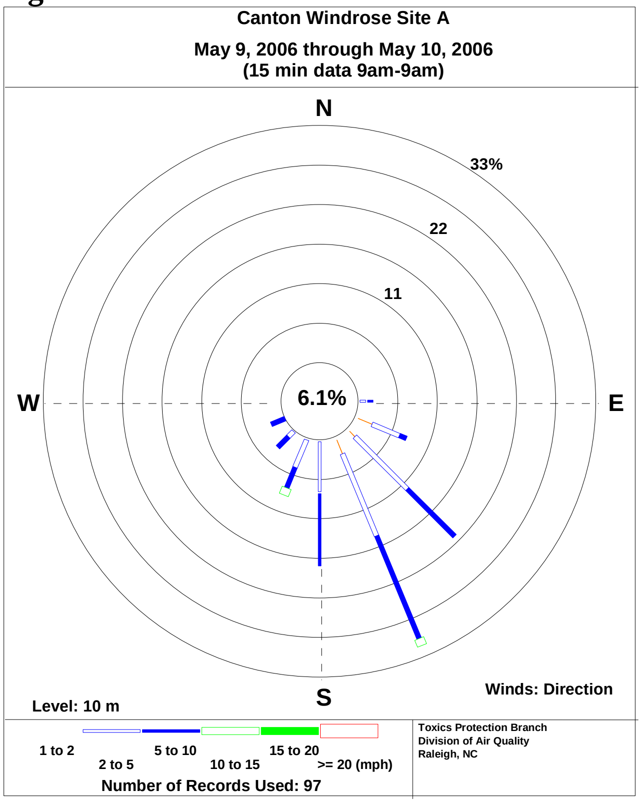

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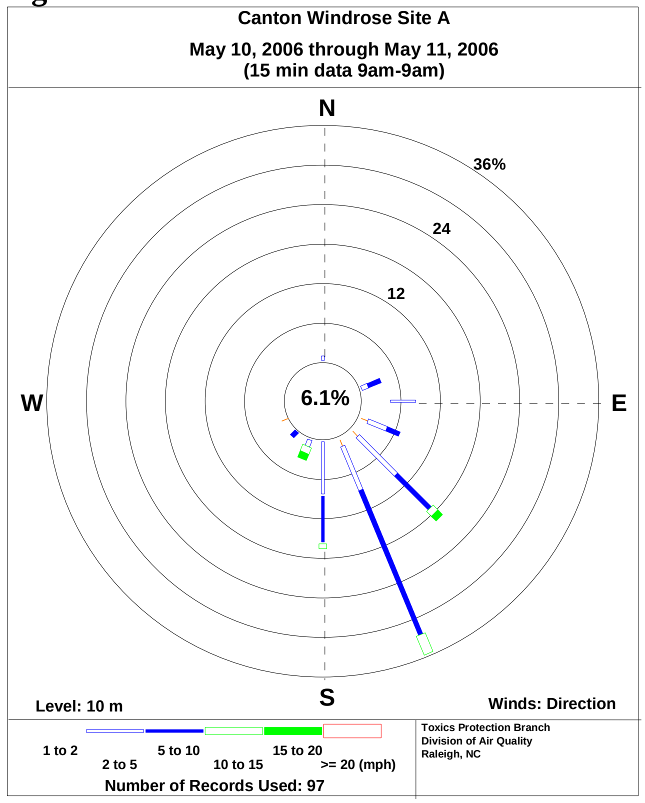

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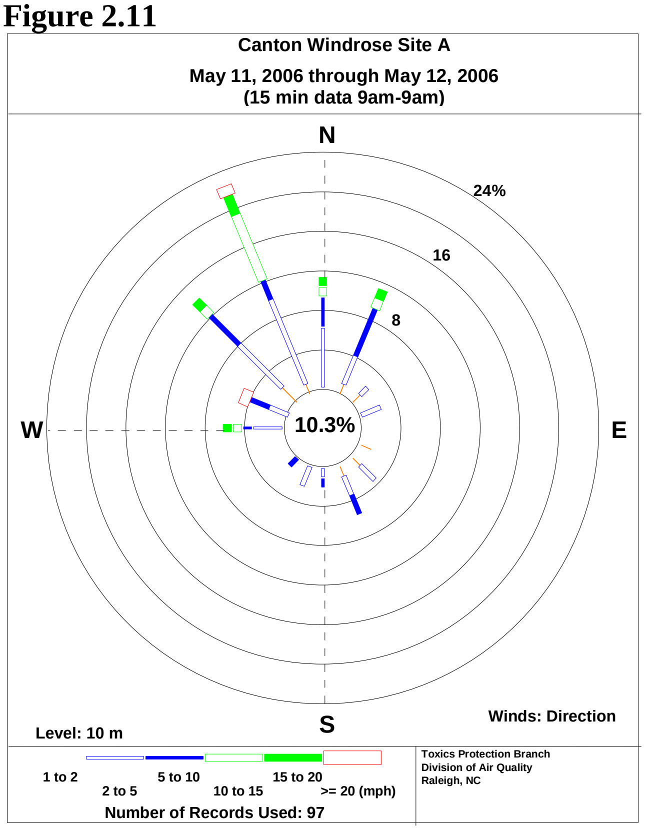

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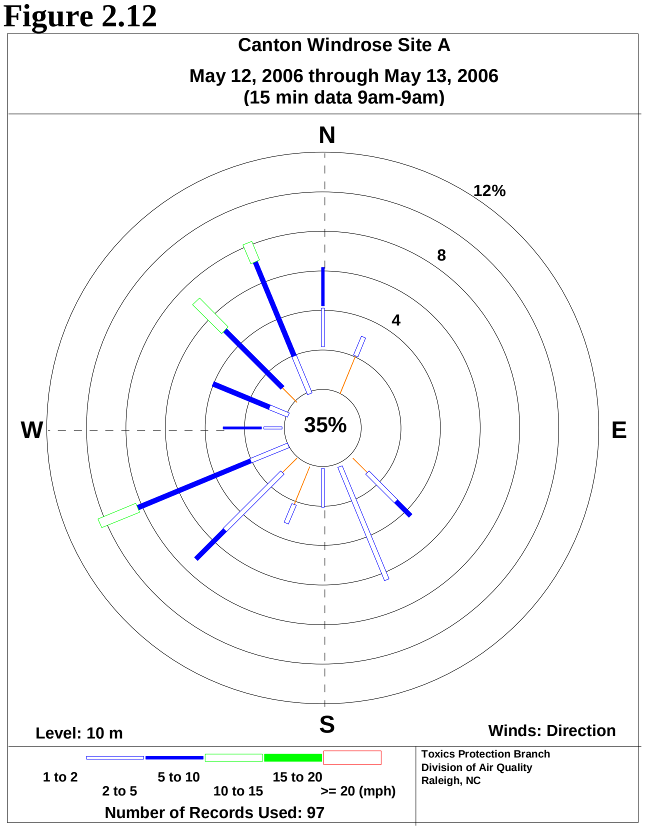

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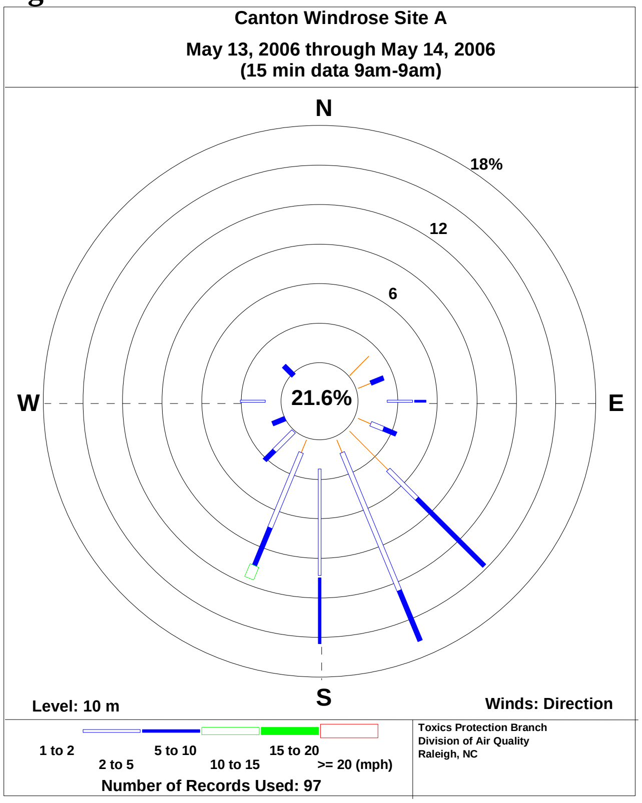

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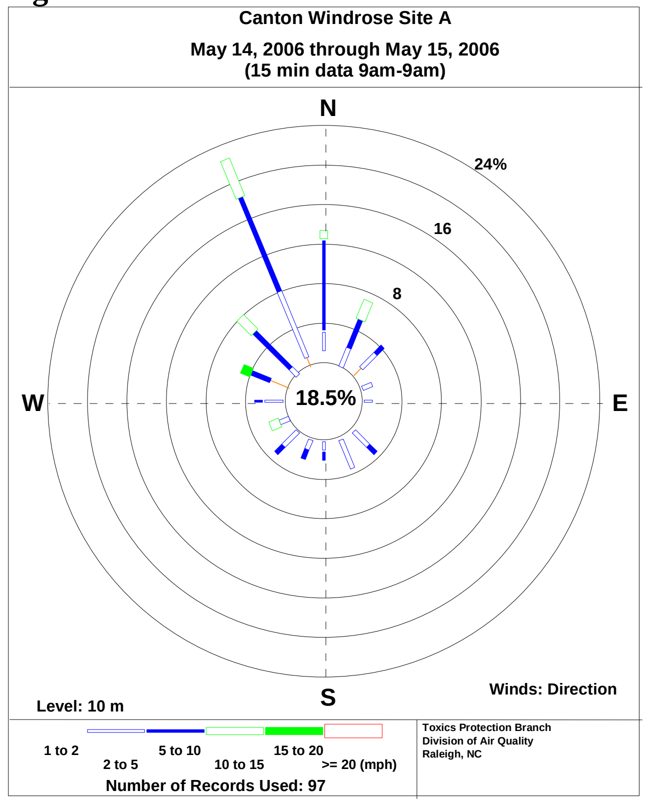

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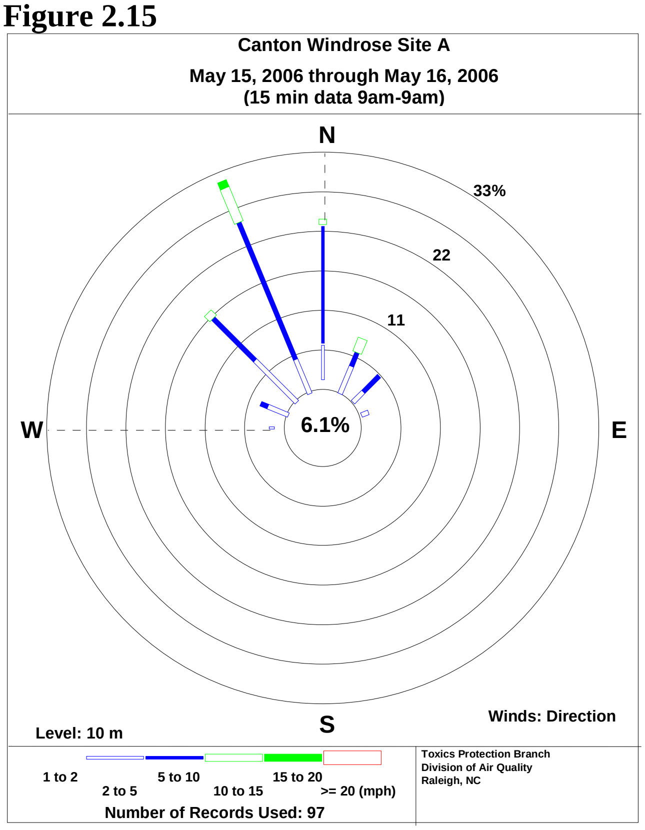

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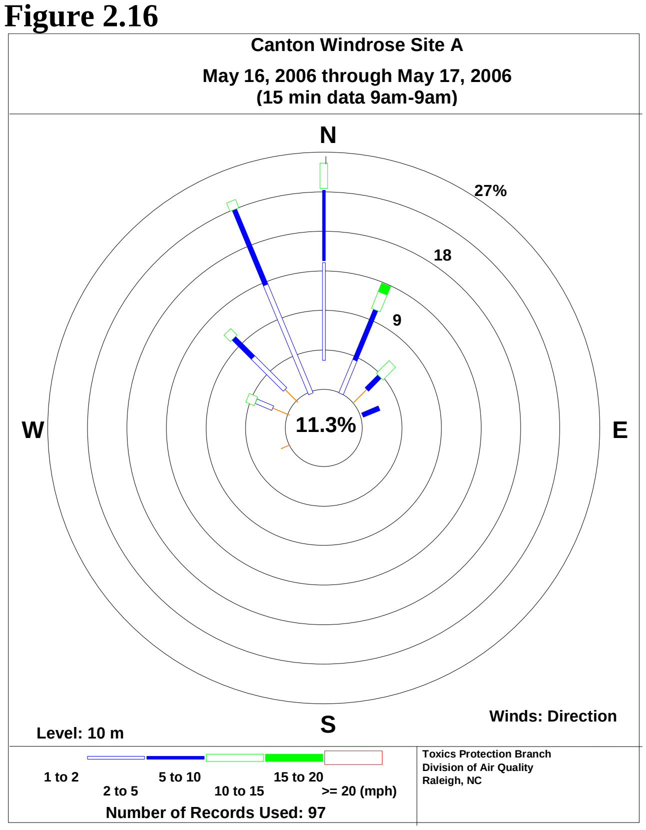

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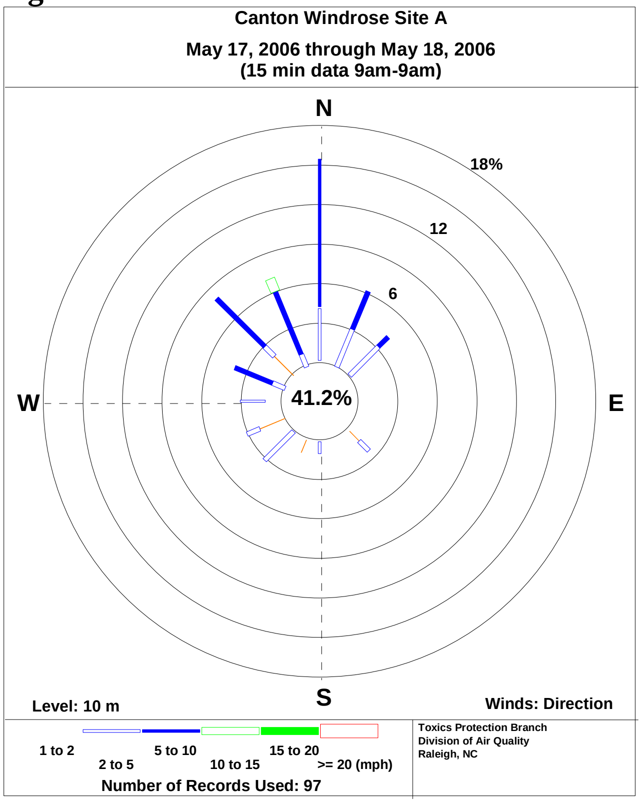

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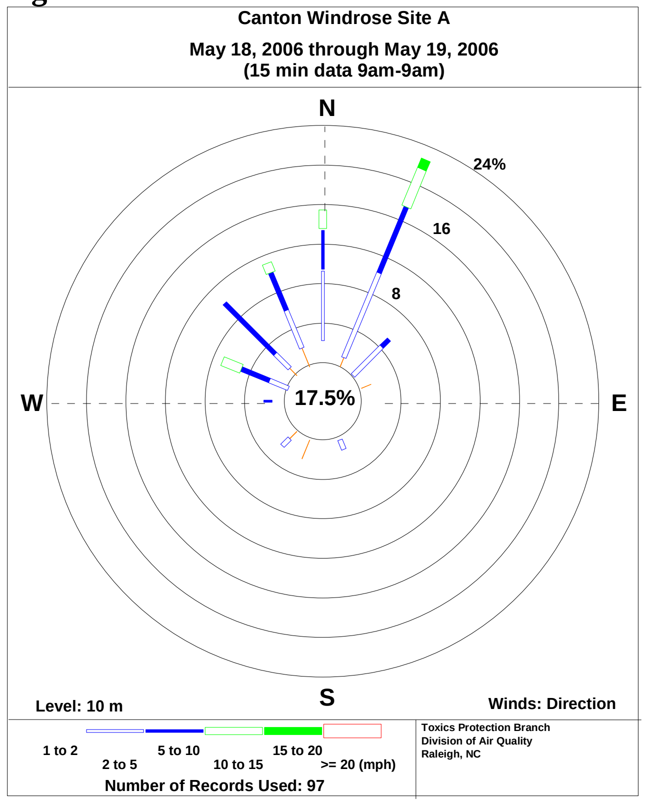

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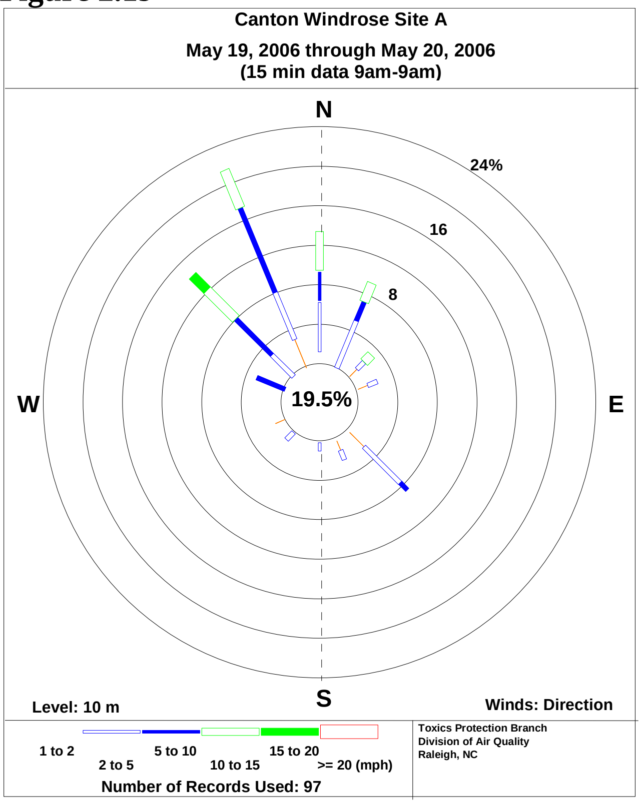

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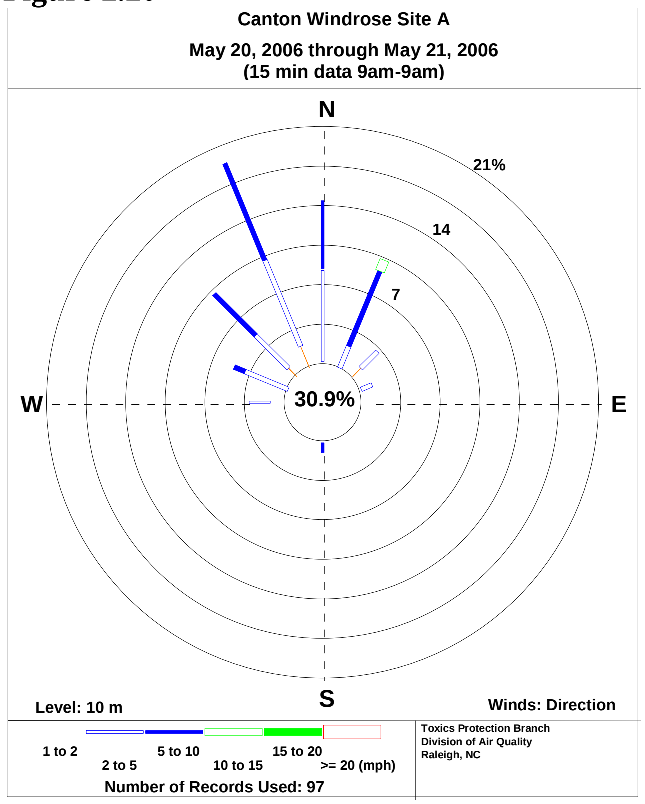

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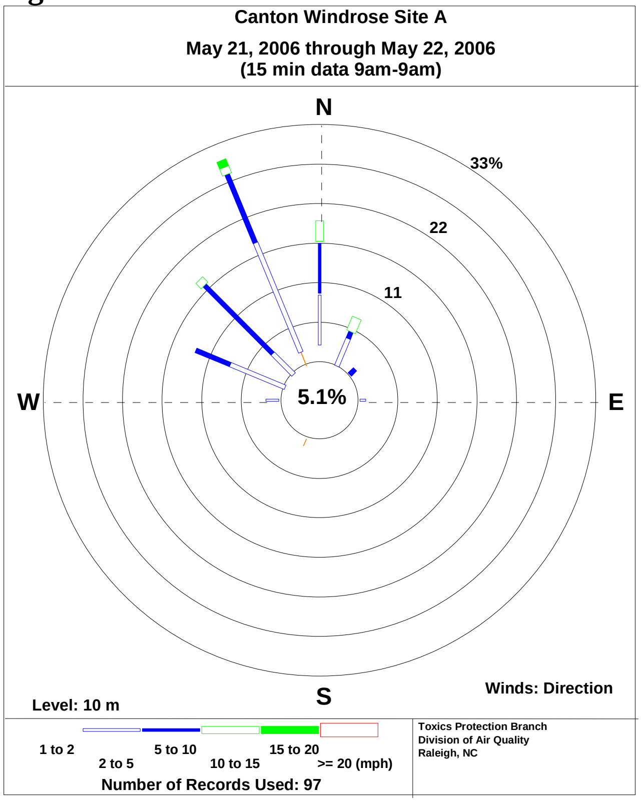

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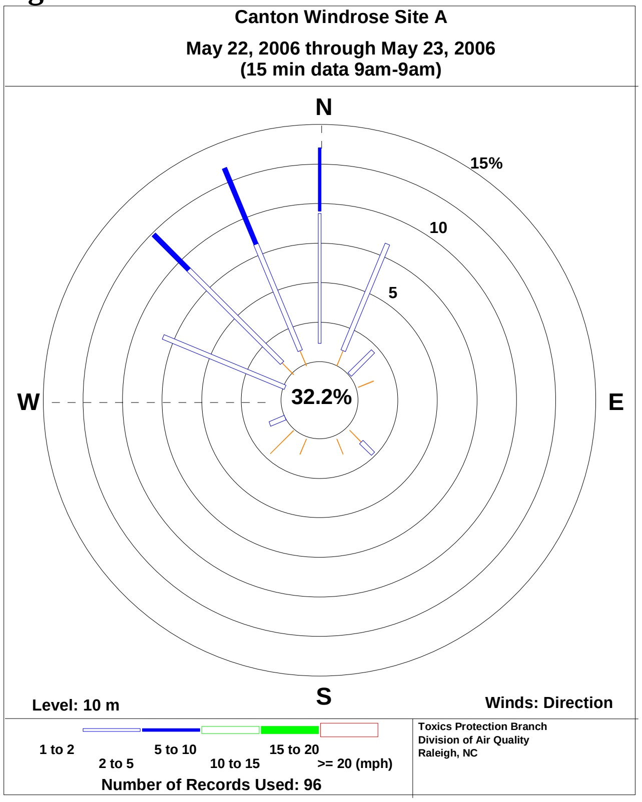

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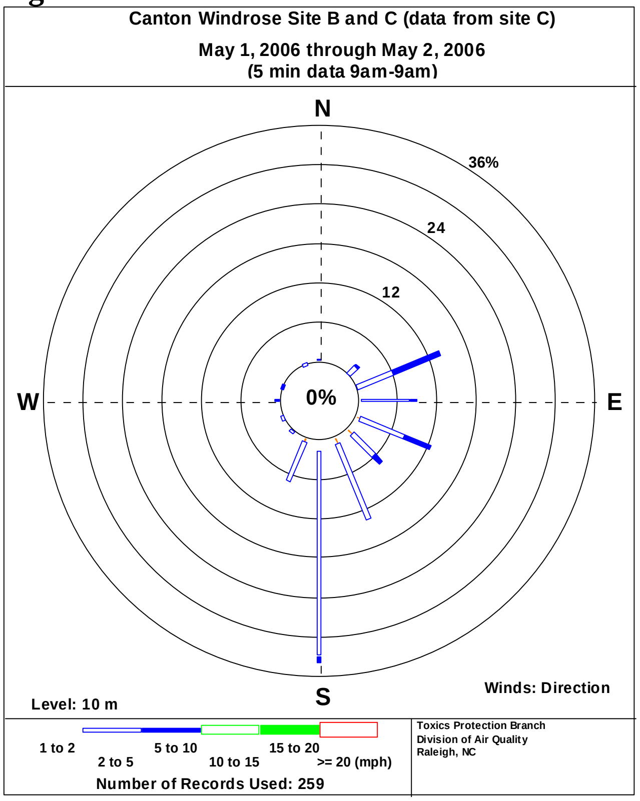

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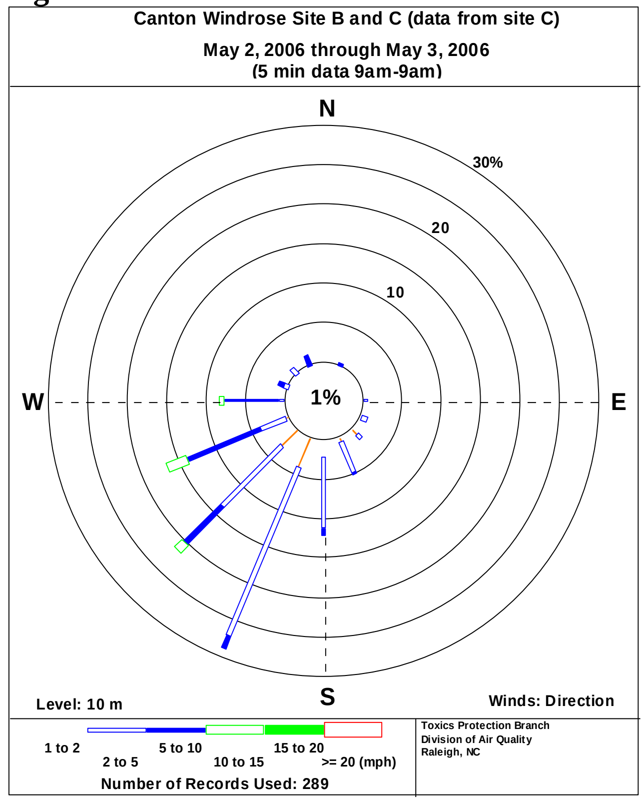

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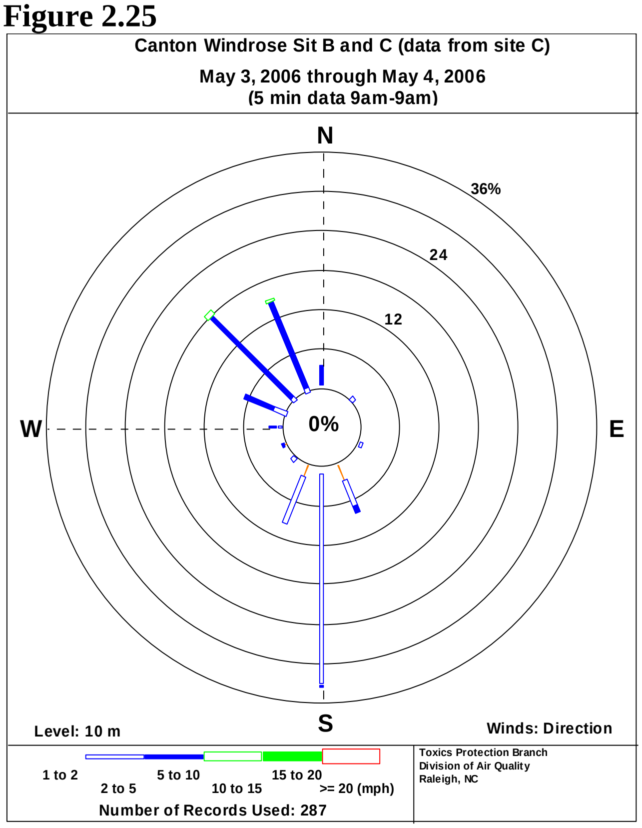

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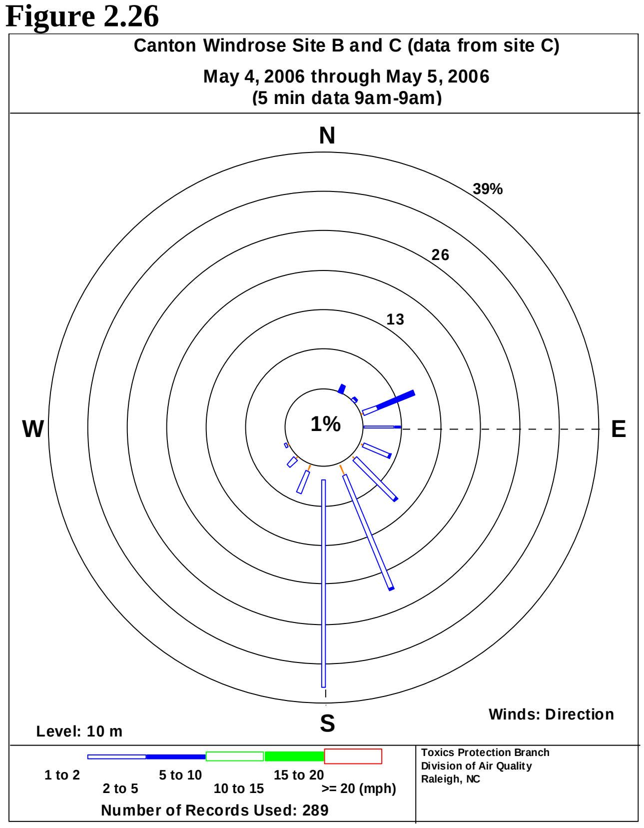

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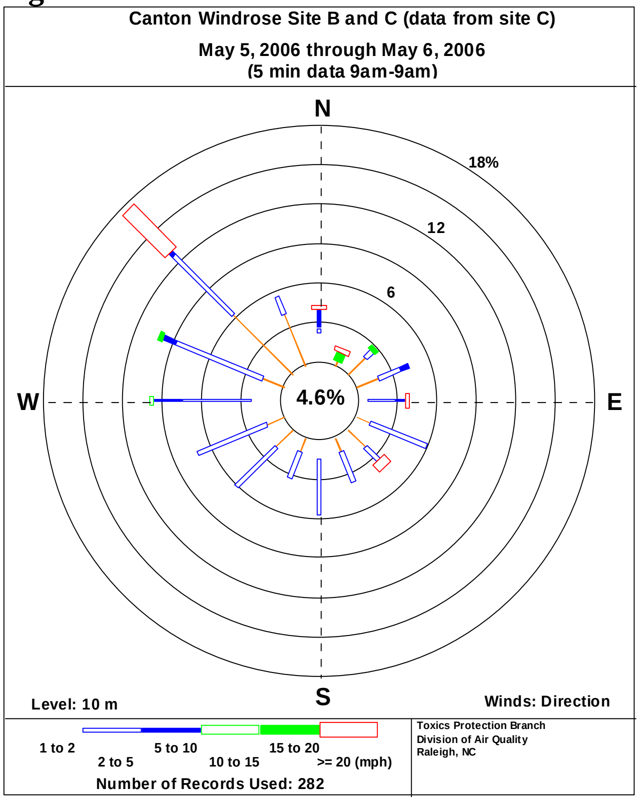

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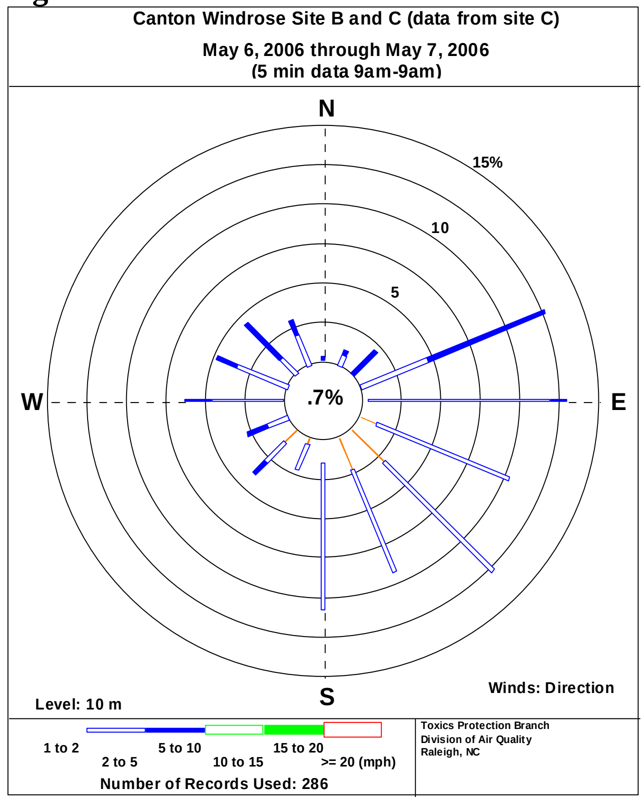

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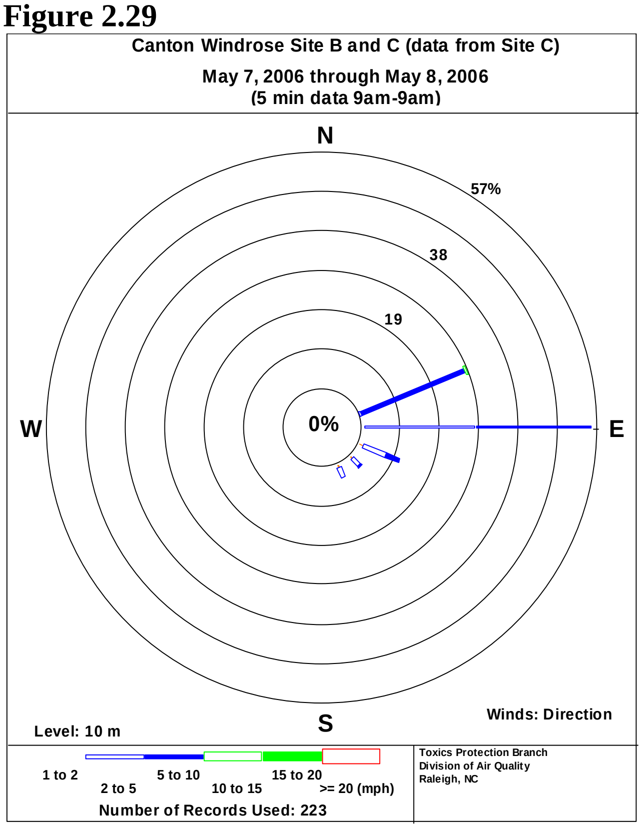

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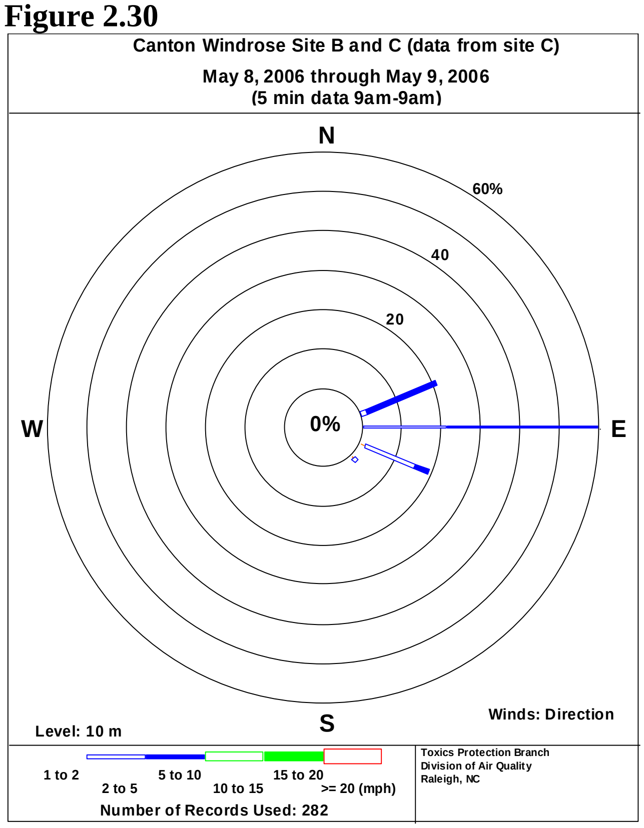

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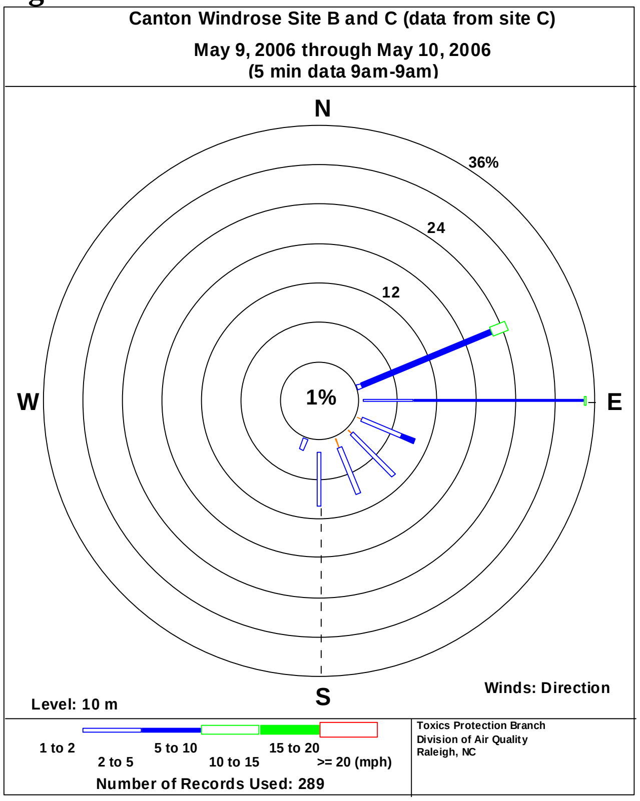

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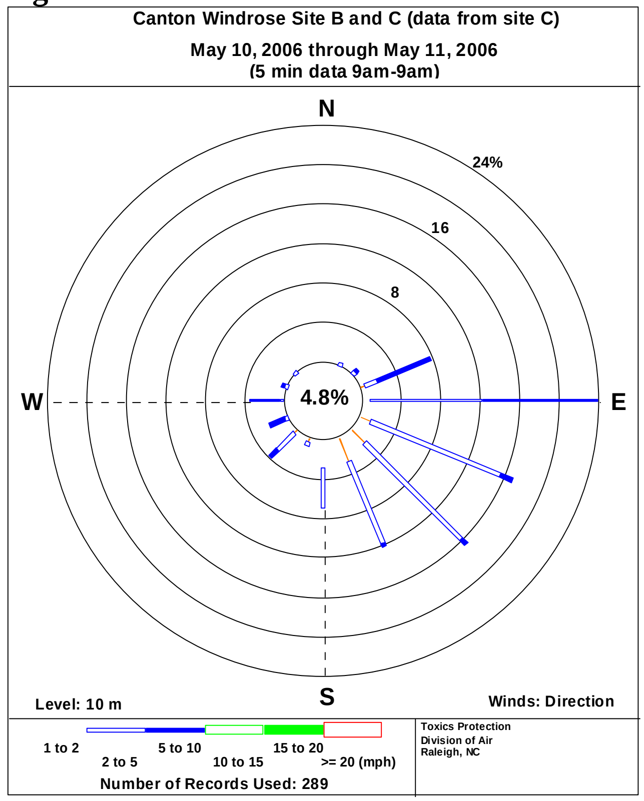

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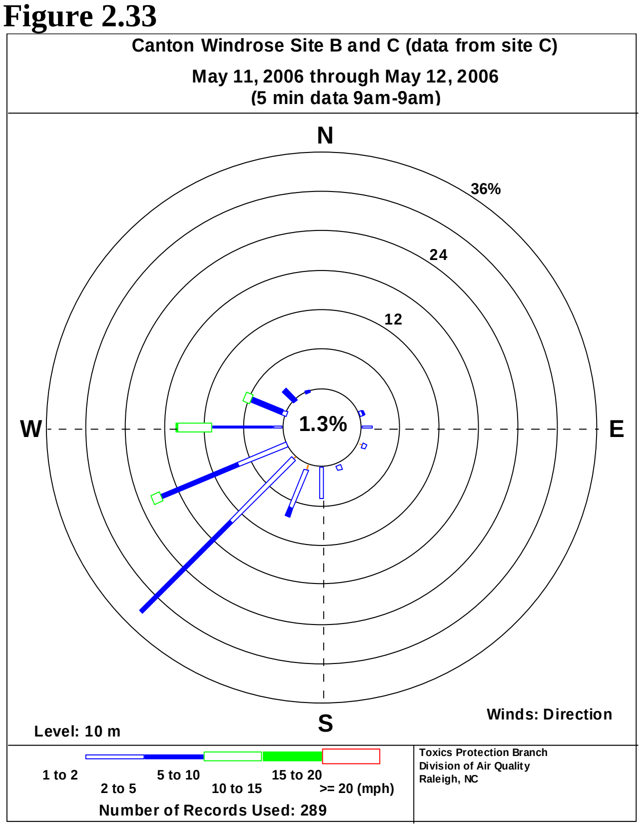

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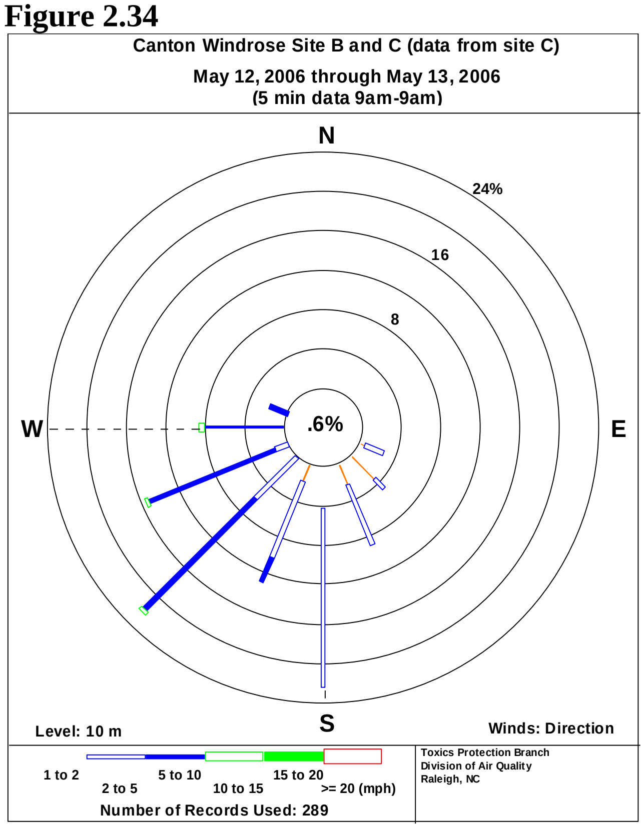

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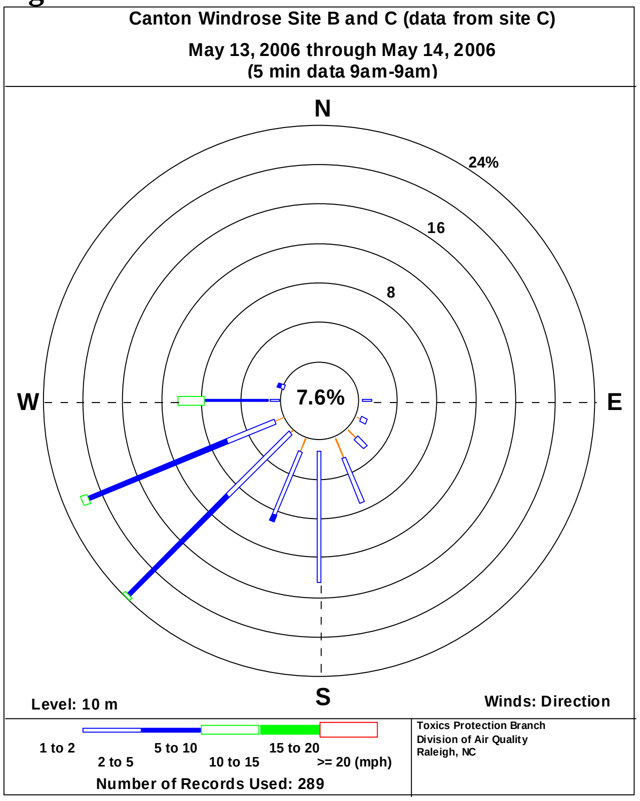

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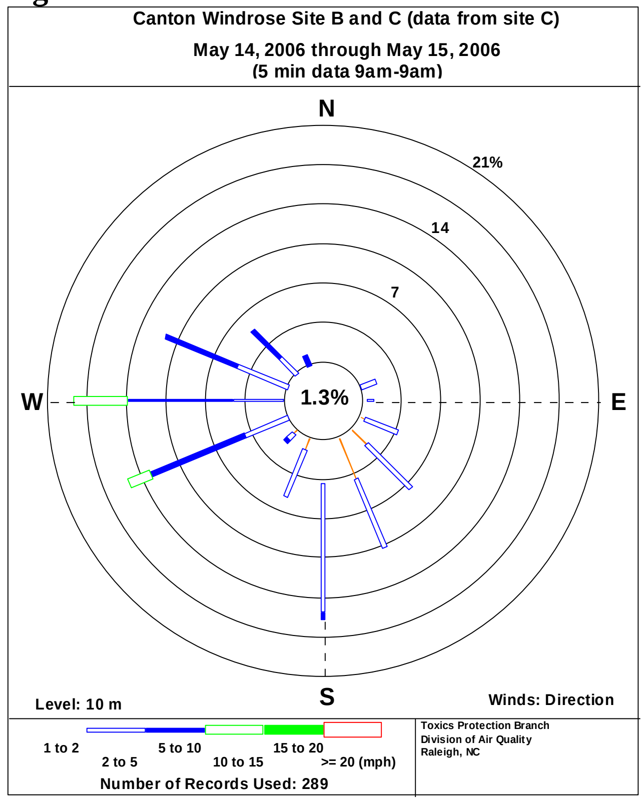

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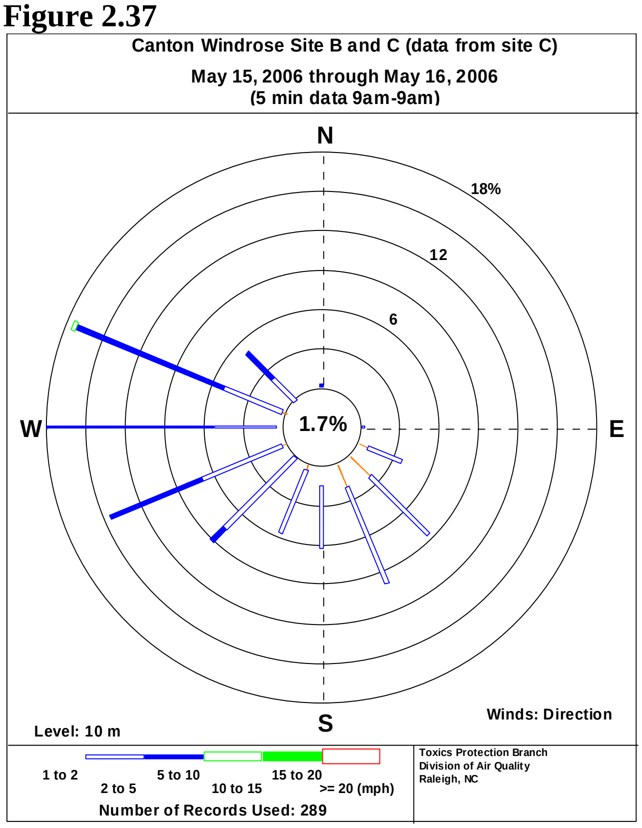

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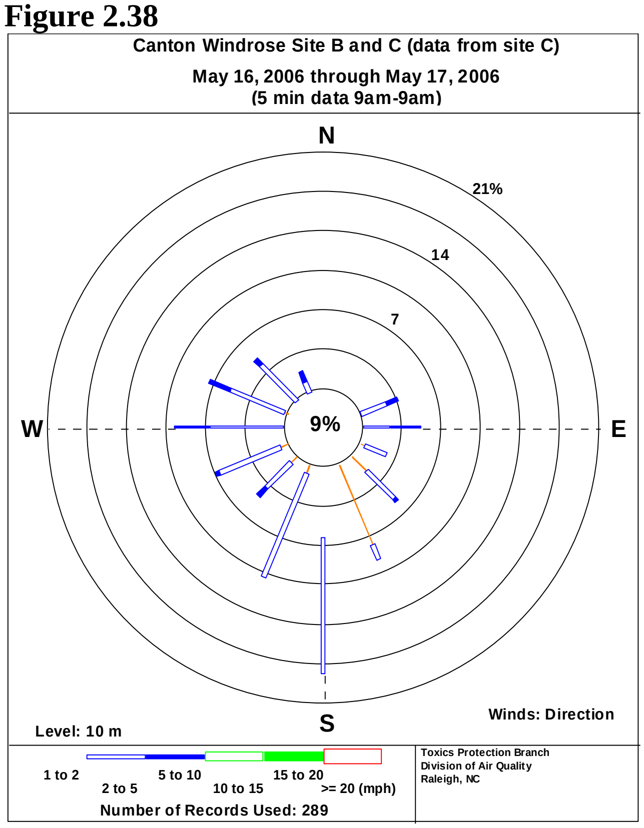

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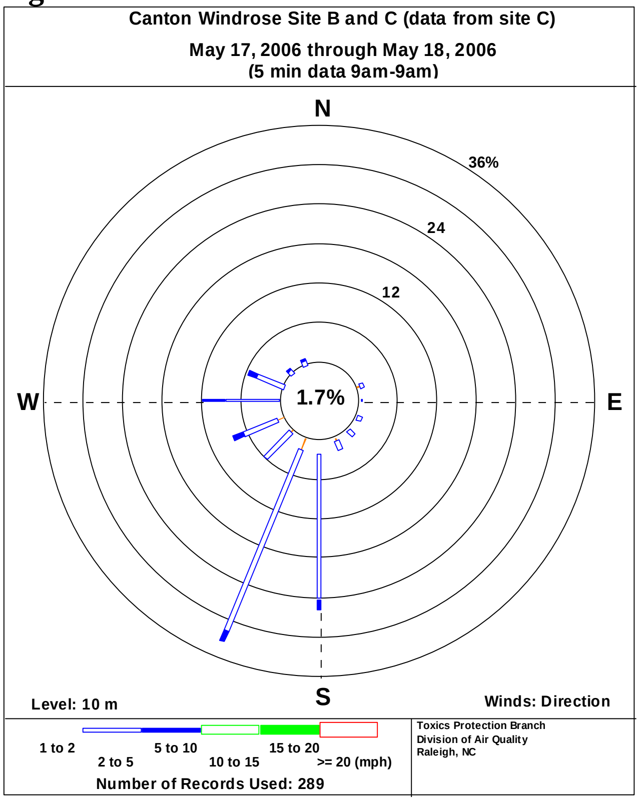

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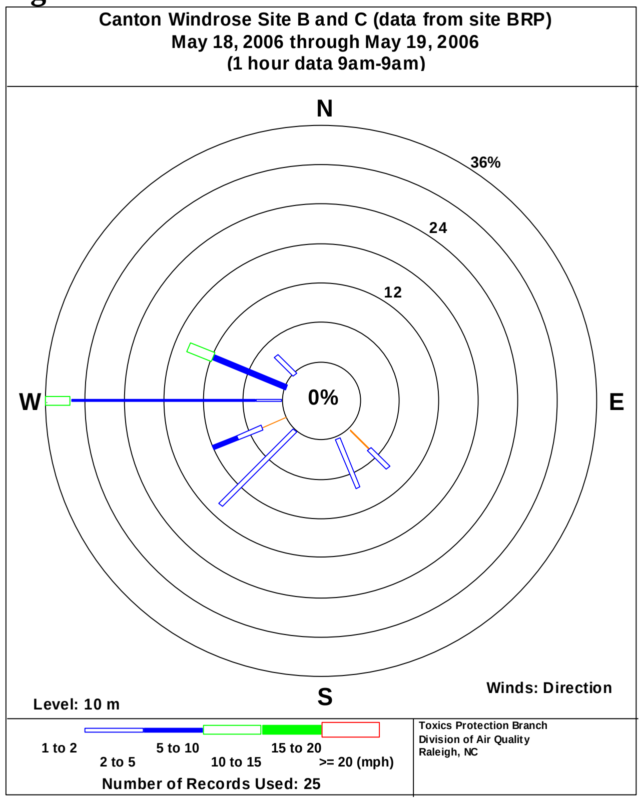


Figure 2.41

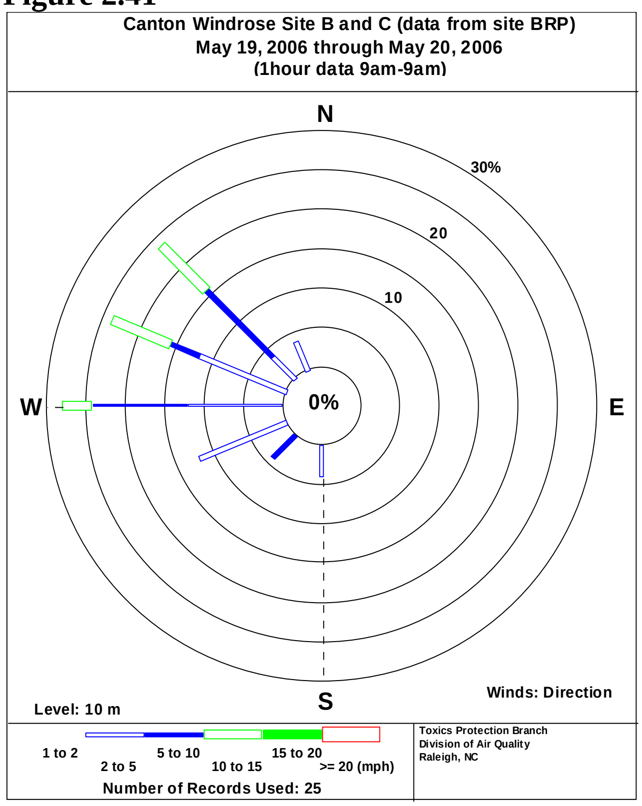


Figure 2.42

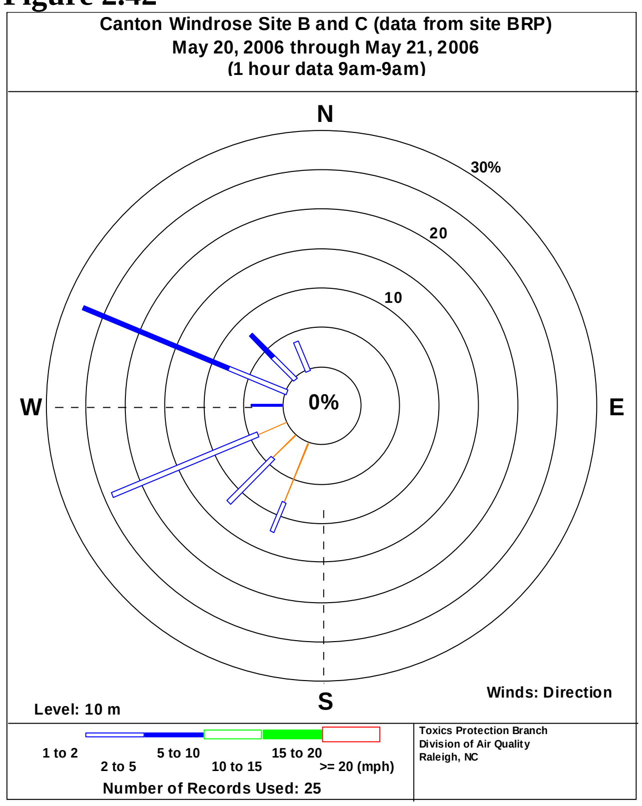
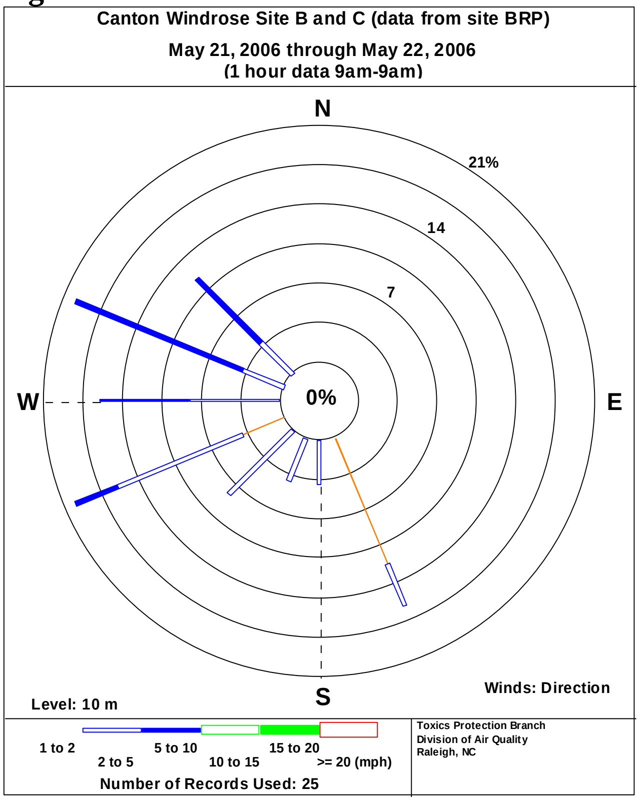


Figure 2.43



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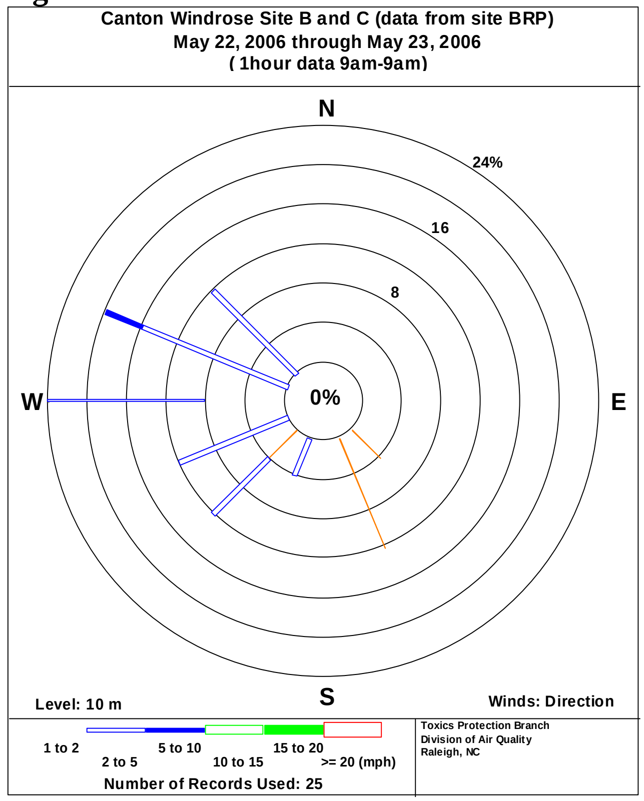

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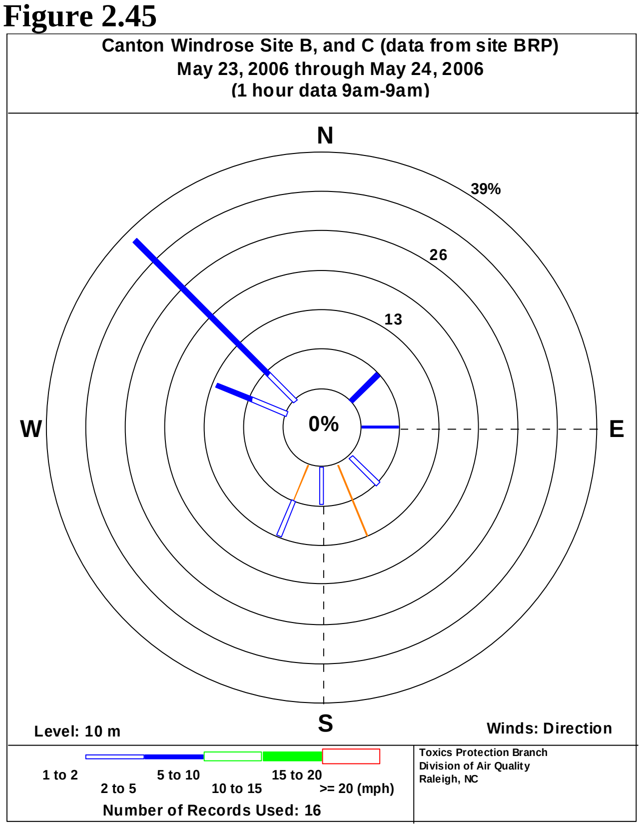


3.0 AMMONIA MONITORING

Ammonia was sampled at Sites A, B and C using a Honeywell (Zellweger) MDA Single Point Monitor (SPM) equipped with a chemically treated paper tape specific for ammonia with an optical sensor that monitors color development (ChemCassette SP#706042 with ChemKey #870861). Quantitation is based on the degree of color change. The Lower Detection Limit (LDL) is established by the manufacturer to be 2.6 ppm (1800 $\mu g/m^3$).

Measurements from each site were continuously data logged and downloaded daily for data analysis using Logic Beach Data Loggers at Sites A and B, and a Campbell Scientific Data Logger at Site C. Data were collected every 20 seconds at Sites A and B and at Site C were collected every 60 seconds. These data collection times are specific to each type of data logger.

Due to intermittent problems with the data loggers and power interruptions, the data collected at Sites A, B and C did not meet the minimum TPB data quality objective (DQO) of 75% for investigative studies. As a result, no extensive data analysis for ammonia was conducted; however it is important to note that no data collected exceeded the LDL of 2.6 ppm. Additional discussion regarding ammonia can be found in Section 8.3

4.0 CARBONYL MONITORING

4.1 Method

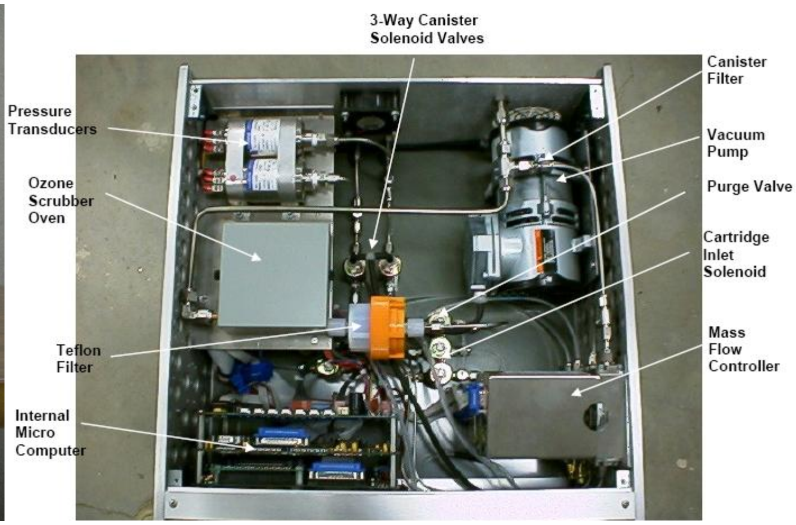
Carbonyl sampling was conducted at Sites A, B, and C for formaldehyde, acetaldehyde, acetone, butyraldehyde, benzaldehyde, valeraldehyde, hexanaldehyde, propionaldehyde, crotonaldehyde, acrolein, isovaleraldehyde, three tolualdehyde isomers, and 2,4 dimethylbenzaldehyde. Carbonyl monitoring was conducted according to EPA Compendium Method TO-11A, *Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC),* EPA/625/R-96/010b. This method involves drawing ambient air through a silica adsorbent cartridge coated with 2,4-dinitrophenylhydrazine (DNPH). Formaldehyde and other aldehydes and ketones form a stable derivative with the DNPH reagent and are retained on the cartridge. The cartridges are then extracted with acetonitrile and analyzed using HPLC. Quantitation is achieved through a comparison of peak areas with those of known certified standards. Samples were analyzed using a Dionex™ DX50 Liquid Chromatography (LC) system equipped with an AD25 tunable absorbance UV detector. The lower quantitation levels (LQL) for the various analytes in air are as follows.

4.2 Sampling Period

Sampling occurred over a continuous 21-day period from May 3-23, 2006 at the three sites. A total of 21 samples were collected at each site for a field recovery rate of 100%.

4.3 Field Equipment

Figure 4.1 Exterior and Interior of ATEC Carbonyl Sampler



4.4 Sampling Procedure

Sampling was conducted using ATEC 2000 (or ATEC 100) Toxic Air Samplers specifically designed for carbonyl sampling. The samplers are equipped with a heated ozone scrubber to remove ozone from the sampled air prior to being drawn through the DNPH cartridge (Waters Corp., #WAT037500) to keep the ozone from destroying the DNPH reagent and/or decomposing the aldehyde-DNPH derivative. The ATEC 2000 uses microprocessor controlled mass flow controllers to monitor and control the sample flow rate through the cartridge. Flow rates for the ATEC 100 were determined using a primary standard BIOS Dry-Cal (DCL-M) during the sampling period.

The sampling inlet was located approximately 3 to 4 meters above ground level, the sampling train was ¼-inch stainless steel tubing that connected the sampling inlet to the ATEC sampler. An automatic timer on the ATEC sampler was programmed to collect samples over a 24-hour period beginning at 9:00 am daily. Sites A, B, and C were equipped with two ATEC samplers each, operating on an alternating schedule to allow for continuous sampling.

4.5 Sample Analysis

After sampling, the DNPH cartridges were collected and immediately placed in a shipping container with freezer ice packs. The cartridges returned under chain of custody to the TPB mobile laboratory at Site C. The cartridges were kept refrigerated until extracted and analyzed.

Each DNPH cartridge was extracted with acetonitrile. The extracts were transferred to a HPLC sample vial or stored under refrigeration until analysis.

Actual flow rate and mobile phase parameters were adjusted to achieve optimum chromatographic separation. Run time was approximately 30 minutes per sample.

A six point calibration curve (0.1, 0.5, 1.0, 5.0, 10.0 and 15.0 μg/mL) was completed before analysis with a successful calibration yielding a correlation coefficient of >0.999. Average Response Factor (RF) values for each compound had to agree within 30% relative standard deviation (RSD) in order to pass calibration. The calibration standards were prepared from a certified standard provided by the Restek Corporation (Aldehyde/ketone-DNPH calibration mix, #31808). A second source "check standard" was also prepared and analyzed with each daily run. This "check standard" was provided by Supelco (TO-11 Aldehyde/ketone-DNPH calibration mix, #47285-U). To convert analytical results to air borne concentration, the HPLC data was adjusted for the total extract volume, the total sampled air volume, and the molecular weight.

4.6 Data Results

Tables 4.1 – 4.3 present validated data for formaldehyde, acetaldehyde, acetone, propionaldehyde, butyraldehyde, benzaldehyde, isovaleraldehyde, valeraldehyde, tolualdehyde isomers and hexanaldehyde for Sites A, B, and C. Acrolein was eliminated from data analysis because EPA has invalidated the sampling portion of the compendium method for this compound. Crotonaldehyde, o-tolualdehyde, and 2,4-dimethylbenzaldehyde were eliminated from data analysis because sample analysis indicated that none of the airborne concentrations were above the LQL.

A review of field logs for carbonyl samples collected May 4-6, 2006 at Sites A, B, and C indicates sampling errors at Site A only. These errors are all flow tolerance exceedances. The sample flow rate is controlled to 1 L/min with a tolerance of ±3% by a mass flow device in the ATEC 2000 sampler. Flow rates outside the tolerance range are tagged as flow tolerance exceedances. Sampling data having such exceedances are invalid and not used in any resulting data analysis.

Table 4.1 Site A Carbonyl Data

Sample Name Concentrations ppbv	**Formaldehyde**	**Acetaldehyde**	**Acetone**	**Propionaldehyde**	**Butyraldehyde**	**Benzaldehyde**	**Isovaleraldehyde**	**Valeraldehyde**	**m/p-Tolualdehyde**	**Hexanaldehyde**
Lower Quantitation Level in Air ppbv	0.29	0.20	0.15	0.15	0.12	0.08	0.10	0.10	0.07	0.09
C050306A	1.2	-	1.4	-	-	0.34	-	-	-	0.30
C050406A (invalidated)	59.2	0.24	-	-	0.24	0.81	-	-	-	-
C050506A (invalidated)	79.0	-	-	-	0.18	0.82	-	0.39	-	1.30
C050606A (invalidated)	20.7	2.4	0.40	0.32	0.28	0.26	-	-	-	-
C050706A	3.3	0.60	0.73	-	0.18	-	-	0.19	-	0.40
C050806A	3.7	1.0	0.60	0.24	0.19	-	-	-	-	-
C050906A	5.0	1.1	0.59	0.24	0.18	-	-	-	-	-
C051006A	4.9	0.86	0.42	0.18	0.17	-	-	-	-	-
C051106A	4.6	0.89	0.58	0.24	-	-	-	-	-	-
C051206A	4.2	1.0	0.86	0.25	-	-	-	-	-	-
C051306A	4.3	1.0	0.56	0.14	0.19	0.16	-	-	-	-
C051406A	3.9	0.77	0.61	-	-	-	-	-	-	0.20
C051506A	4.1	0.80	0.98	-	-	-	-	-	-	-
C051606A	5.2	1.0	1.1	0.15	-	-	-	-	-	-
C051706A	4.8	0.97	0.61	-	-	-	-	-	-	-
C051806A	4.2	1.0	0.67	0.26	-	-	-	-	-	-
C051906A	4.8	1.0	0.49	0.25	0.21	-	-	-	-	-
C052006A	5.0	1.2	0.47	0.25	0.28	-	-	-	-	-
C052106A	5.0	1.1	0.54	-	-	-	-	-	-	-
C052206A	1.8	0.56	0.31	-	-	-	-	-	-	0.23
C052306A	7.7	1.8	1.3	0.38	0.24	0.20	-	-	-	-
Average	4.3	0.93	0.72	0.17	0.12	0.07	0.05	0.06	0.04	0.10
Maximum	7.7	1.8	1.3	0.38	0.28	0.20	0.05	0.19	0.04	0.40
# samples > LQL	18	17	18	9	8	3	0	1	0	4
# of samples	18	18	18	18	18	18	18	18	18	18
% Data > LQL	100%	94%	100%	50%	44%	17%	0%	6%	0%	22%
Dashes represent 0.5 times the LQL in air for statistical evaluation purposes										

Table 4.2 Site B Carbonyl Data

Sample Name Concentrations ppbv	**Formaldehyde**	**Acetaldehyde**	**Acetone**	**Propionaldehyde**	**Butyraldehyde**	**Benzaldehyde**	**Isovaleraldehyde**	**Valeraldehyde**	**m/p-Tolualdehyde**	**Hexanaldehyde**
Lower Quantitation Level in Air ppb	0.29	0.20	0.15	0.15	0.12	0.08	0.10	0.10	0.07	0.09
C050306B	23.8	2.0	0.46	0.33	0.36	0.31	0.20	0.27	-	0.85
C050406B	41.0	3.8	0.24	0.37	0.33	0.33	-	0.39	-	1.4
C050506B	27.2	3.3	0.32	0.32	0.24	0.32	-	0.44	-	0.91
C050606B	31.3	4.7	0.75	0.32	0.37	0.35	-	-	-	0.19
C050706B	17.5	2.1	0.60	-	-	0.32	0.22	0.43	-	0.75
C050806B	25.8	2.8	0.80	0.24	0.22	0.27	-	-	-	-
C050906B	31.0	3.4	-	-	-	0.07	-	0.27	-	0.49
C051006B	39.1	2.3	0.24	0.28	0.40	0.49	-	-	-	-
C051106B	15.6	2.4	0.89	0.27	0.20	0.21	0.32	0.52	0.23	0.98
C051206B	16.8	2.6	0.77	0.26	0.27	0.23	0.26	-	-	0.45
C051306B	20.3	3.1	0.47	0.32	0.34	0.28	-	-	-	-
C051406B	12.5	2.1	0.72	0.24	0.22	0.20	0.22	0.18	-	0.64
C051506B	16.0	2.4	1.0	0.28	0.26	0.22	-	-	-	0.20
C051606B	21.6	3.2	0.59	0.32	0.33	0.29	0.18	-	-	0.47
C051706B	16.9	2.3	0.60	0.27	0.24	0.26	-	-	-	-
C051806B	14.5	2.1	0.87	0.28	0.23	0.23	-	-	-	-
C051906B	18.8	2.8	0.63	0.32	0.30	0.28	0.17	-	-	0.46
C052006B	36.4	0.30	-	-	0.28	0.56	0.24	0.35	-	0.62
C052106B	-	-	-	-	-	-	-	-	-	0.23
C052206B	0.72	-	-	-	-	-	-	-	-	-
C052306B	31.0	1.4	-	0.36	0.45	0.39	-	-	-	0.27
Average	21.8	2.4	0.49	0.25	0.25	0.27	0.12	0.17	0.08	0.44
Maximum	41.0	4.7	1.00	0.37	0.45	0.56	0.32	0.52	0.23	1.4
# samples > LQL	20	19	16	16	17	18	8	8	1	15
# of samples	21	21	21	21	21	21	21	21	21	21
% Data > LQL	95%	90%	76%	76%	81%	86%	38%	38%	5%	71%
Dashes represent 0.5 times the LQL in air for statistical evaluation purposes										

Table 4.3 Site C Carbonyl Data

Sample Name Concentrations ppbv	**Formaldehyde**	**Acetaldehyde**	**Acetone**	**Propionaldehyde**	**Butyraldehyde**	**Benzaldehyde**	**Isovaleraldehyde**	**Valeraldehyde**	**m/p-Tolualdehyde**	**Hexanaldehyde**
Lower Quantitation Level in Air ppb	0.29	0.20	0.15	0.15	0.12	0.08	0.10	0.10	0.07	0.09
C050306C	1.8	1.6	2.2	-	-	-	-	-	-	-
C050406C	6.6	1.2	0.44	-	0.31	0.17	0.13	0.20	-	0.65
C050506C	2.0	0.70	0.72	-	-	-	-	-	-	-
C050606C	0.53	0.39	0.55	-	-	-	-	-	-	-
C050706C	3.7	1.1	0.42	0.24	0.24	-	-	-	-	-
C050806C	1.1	0.38	0.72	-	-	-	-	-	-	-
C050906C	1.2	0.42	0.47	-	-	-	-	-	-	-
C051006C	1.7	0.63	0.49	-	-	-	0.16	-	-	0.53
C051106C	1.7	0.66	0.81	-	-	-	-	-	-	-
C051206C	1.5	0.61	0.84	-	-	-	-	-	-	-
C051306C	1.6	0.62	0.53	-	-	-	0.18	-	-	0.43
C051406C	1.4	0.66	0.68	-	-	-	-	-	-	-
C051506C	1.4	0.68	0.74	-	-	-	0.29	-	-	0.66
C051606C	1.3	0.71	0.65	-	-	-	-	-	-	-
C051706C	1.5	0.64	0.53	-	-	-	0.18	-	-	0.47
C051806C	1.9	0.68	0.88	-	-	-	0.39	0.51	0.25	1.1
C051906C	1.8	0.71	0.50	-	0.21	-	-	-	-	-
C052006C	2.7	0.95	0.61	-	0.30	-	-	-	-	-
C052106C	0.7	-	-	-	-	-	-	-	-	-
C052206C	2.1	1.0	0.77	-	-	-	-	-	-	-
C052306C	2.8	1.4	1.1	0.30	-	-	-	-	-	-
Average	2.0	0.76	0.70	0.09	0.10	0.05	0.10	0.8	0.08	0.21
Maximum	6.6	1.6	2.2	0.30	0.31	0.17	0.39	0.51	0.25	1.1
# samples > LQL	21	20	20	2	4	1	6	2	1	6
# of samples	21	21	21	21	21	21	21	21	21	21
% Data > LQL	100%	95%	95%	10%	19%	5%	29%	10%	5%	29%
Dashes represent 0.5 times the LQL in air for statistical evaluation purposes										

The data from Tables 4.1-4.3 are plotted in Figures 4.2-4.11 over sampling day for each carbonyl compound. The invalidated data for Site A are plotted but are not included in any further analysis and are shown as unconnected data points in each figure. Concentrations scales vary from figure to figure. Vertical lines in each figure segregate air monitoring into pre-outage, outage, and post-outage periods at BRPP.

The data in Figures 4.2-4.11 by carbonyl compound are replotted in Figures 4.12-4.14 by site to show any temporal associations between carbonyl compounds. It is evident from these graphs that formaldehyde and acetaldehyde are the primary carbonyl compounds observed in the study area. Their contribution to elevated risk will be discussed in the risk assessment section.

Based on information provide to DAQ from BRPP in a July 2007 air quality modeling study, the maximum formaldehyde concentration of 11.1 $\mu g/m^3$ (9.0 ppb) occurred at 266 meters from the center of the facility at an angle of 42 degrees east of north which represents approximately 10% of the acceptable ambient level (based on a 1 hour acute exposure). It is possible to conclude from these data that the modeled formaldehyde concentration expected to occur at Site B would be less than or equal to 11.1 $\mu g/m^3$ (9.0 ppb), however formaldehyde concentrations were observed to be an average of 27 $\mu g/m^3$ (21.9 ppb) at Site B. This implies that either the model is under reporting formaldehyde or there are additional sources of formaldehyde. It seems likely that because Site B was located in a BRPP parking lot that automobile emissions are a likely additional source.

Figure 4.2 Formaldehyde Results for Sites A, B, and C

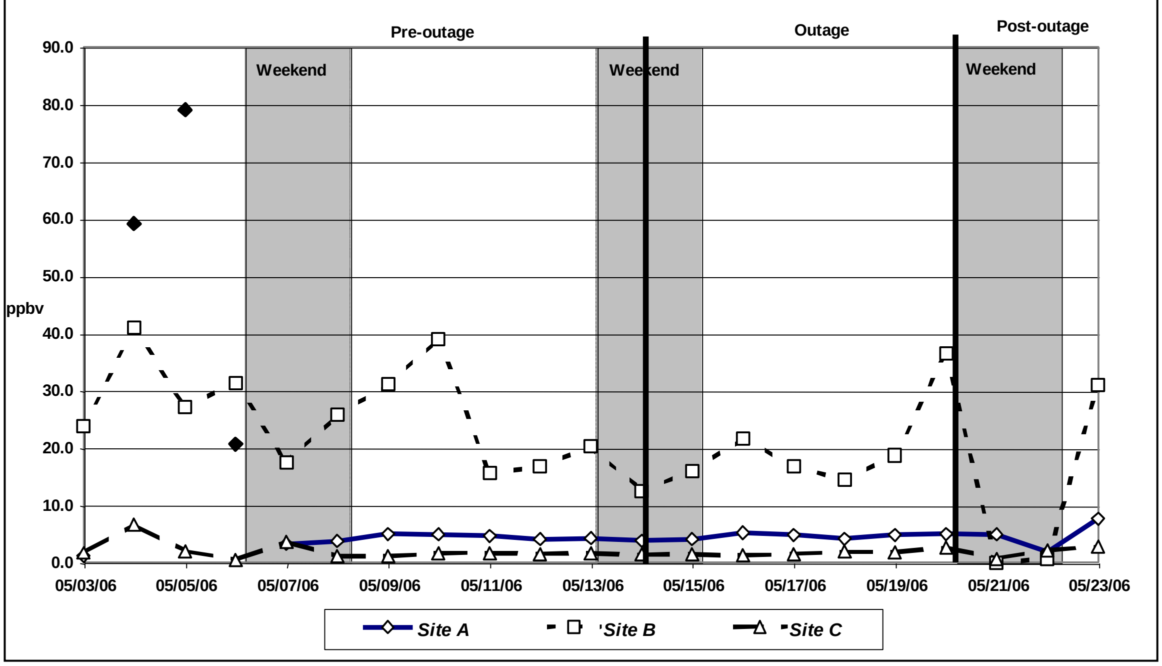


Figure 4.3 Acetaldehyde Results for Sites A, B, and C

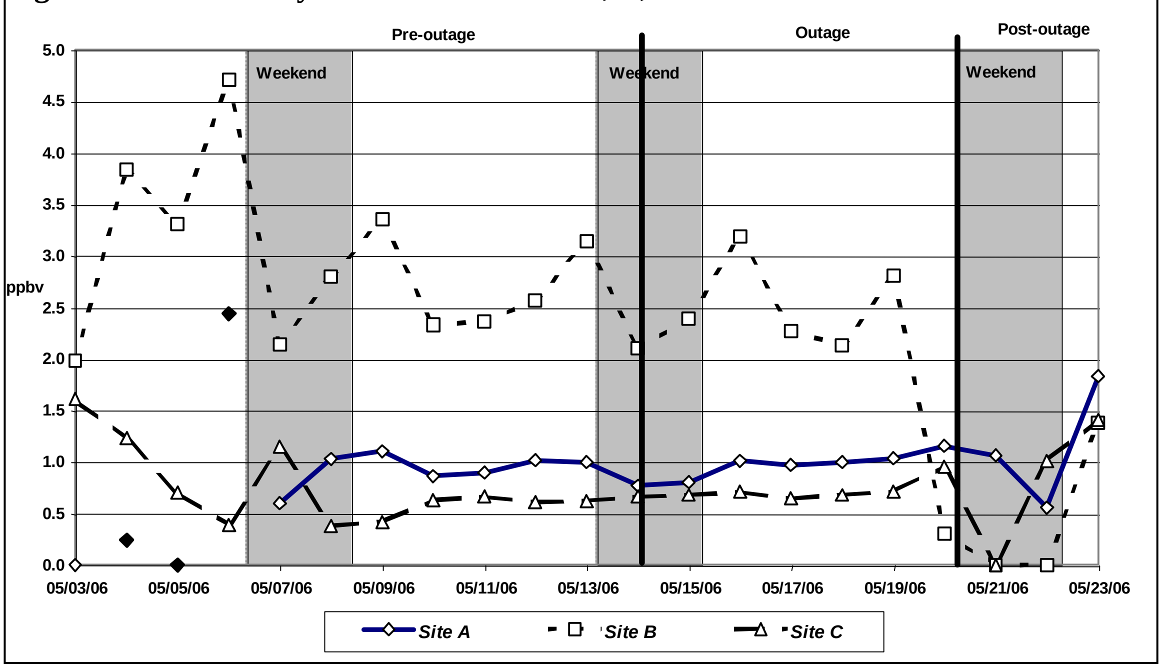


Figure 4.4 Acetone Results for Sites A, B, and C

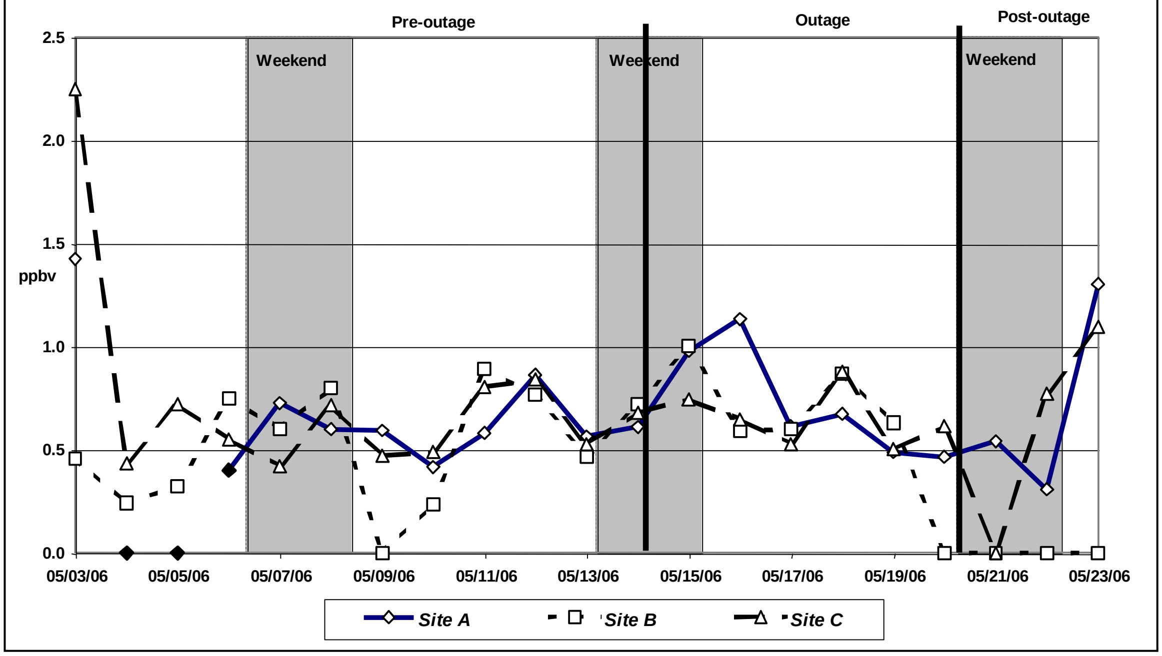


Figure 4.5 Propionaldehyde Results for Sites A, B, and C

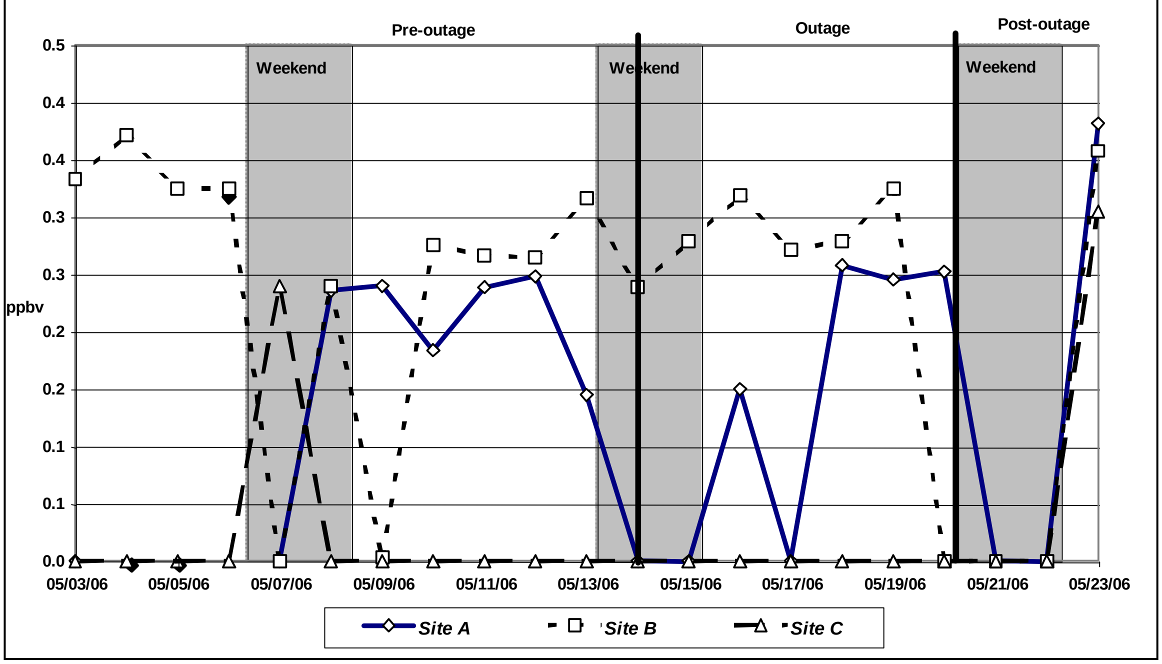


Figure 4.6 Benzaldehyde Results for Sites A, B, and C

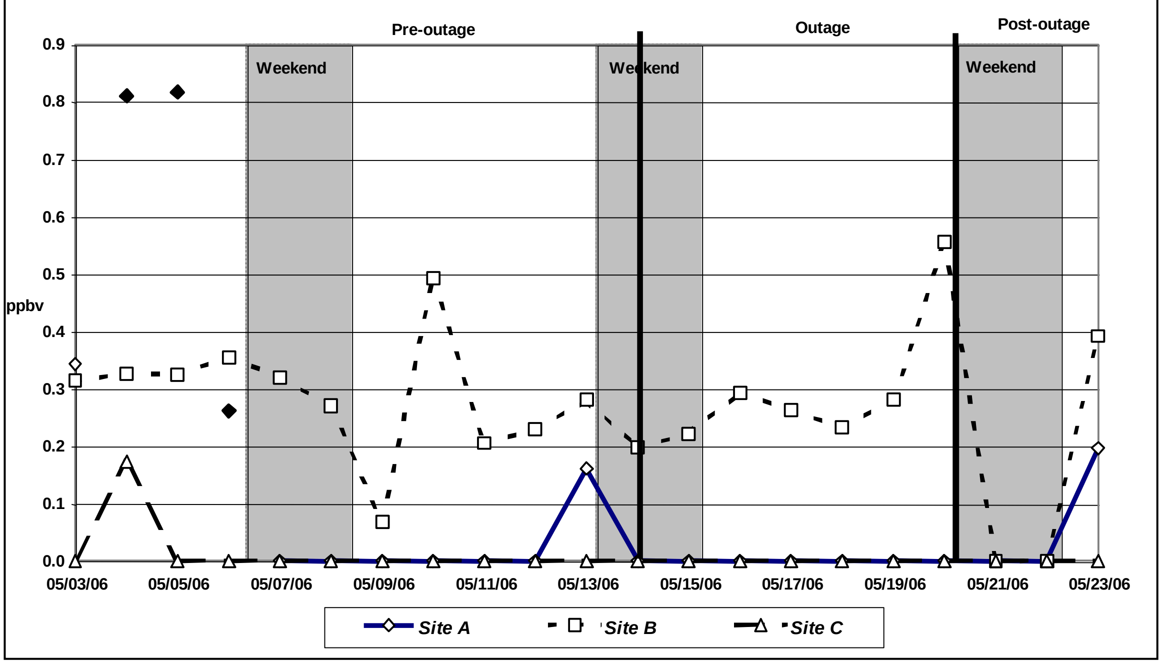


Figure 4.7 Butyraldehyde Results for Sites A, B, and C

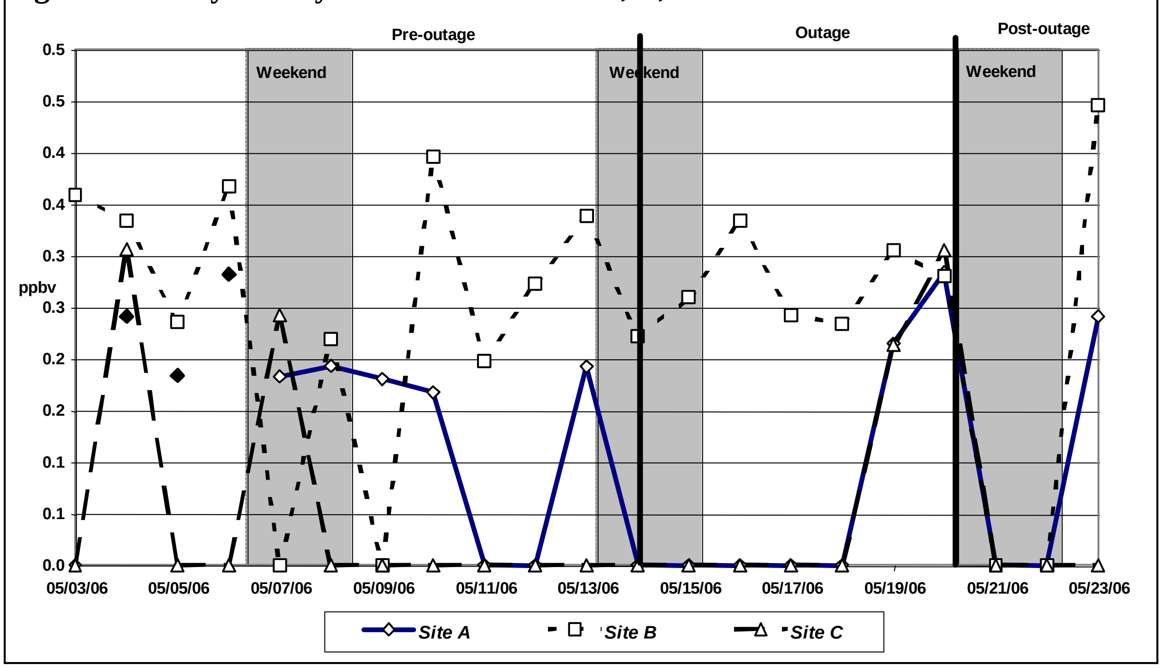


Figure 4.8 Isovaleraldehyde Results for Sites A, B, and C

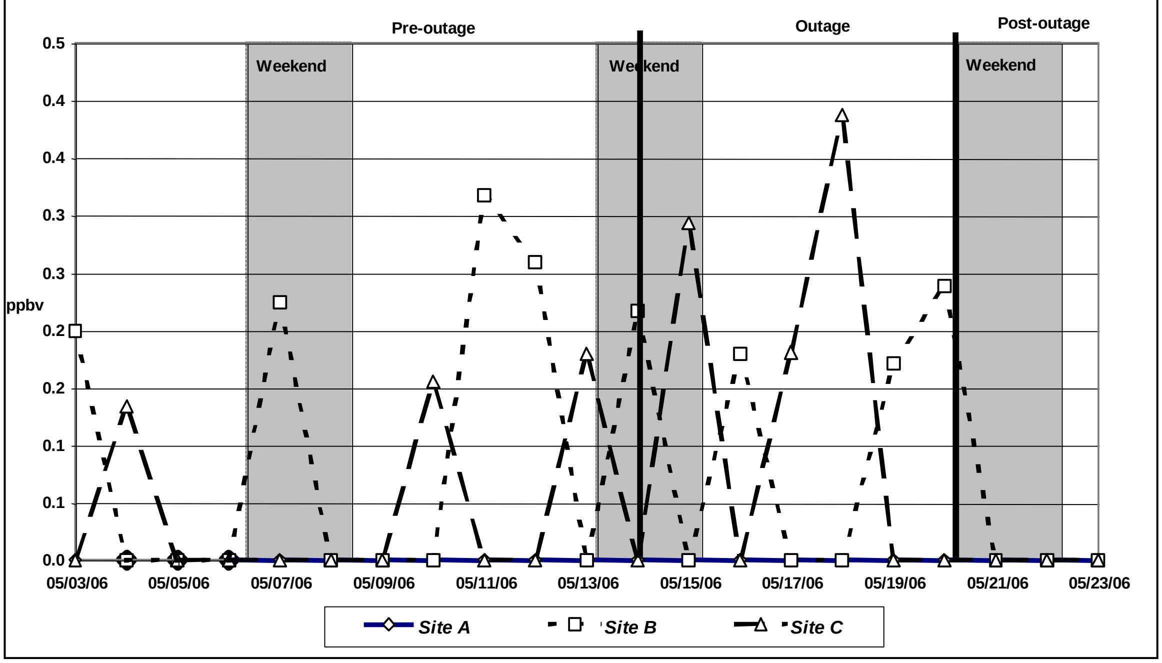


Figure 4.9 Valeraldehyde Results for Sites A, B, and C

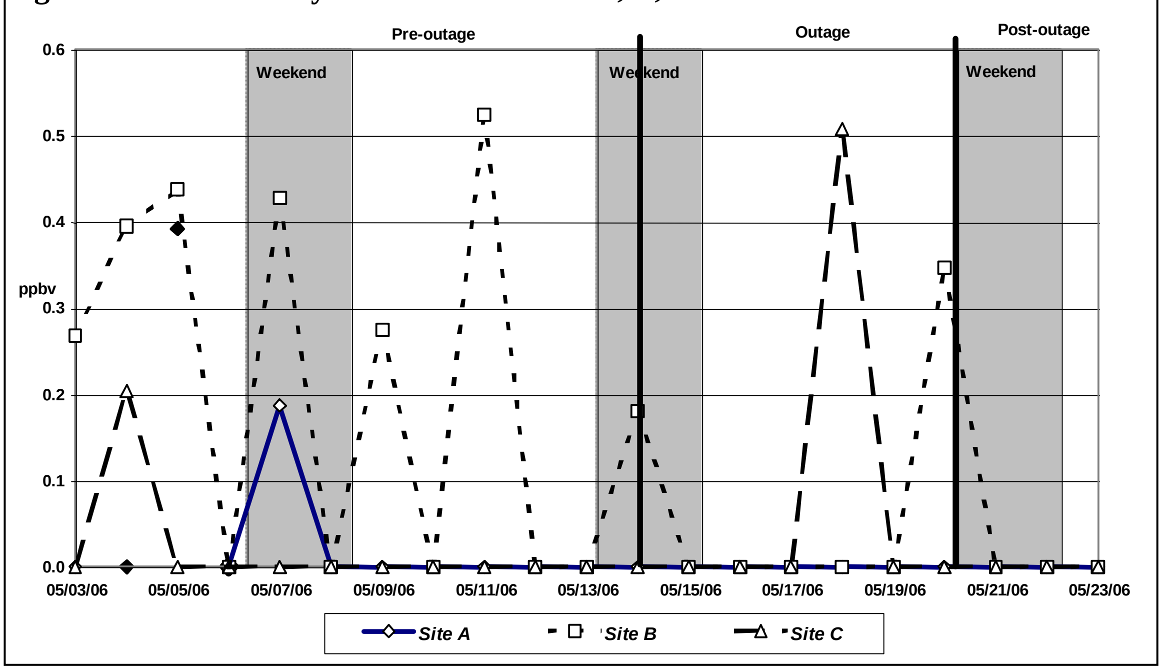


Figure 4.10 m/p-Tolualdehyde Results for Sites A, B, and C

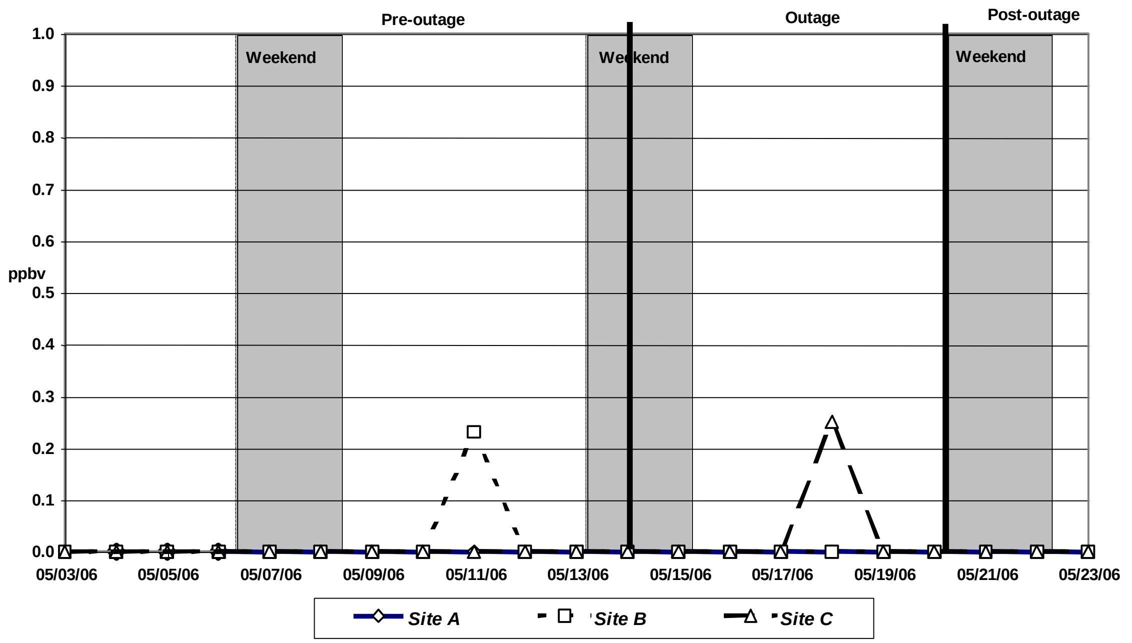


Figure 4.11 Hexanaldehyde Results for Sites A, B, and C

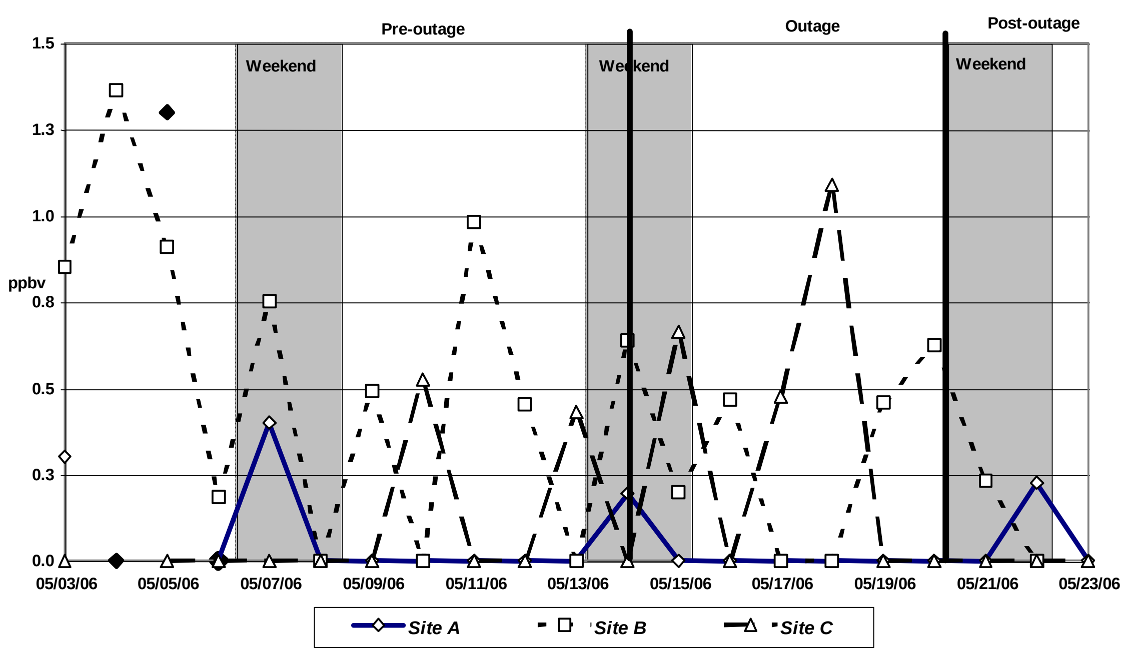


Figure 4.12 Temporal Carbonyl Results at Site A

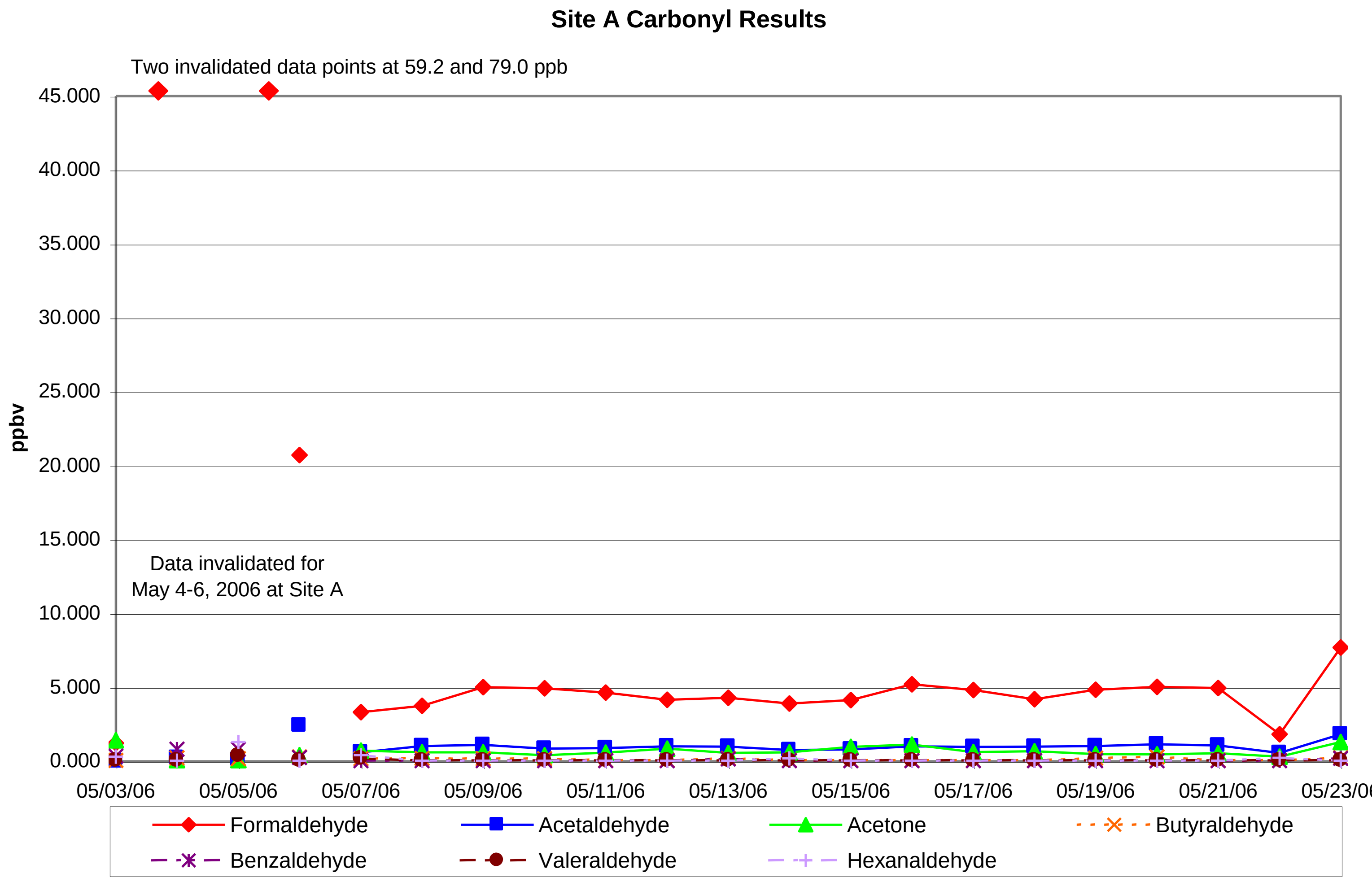


Figure 4.13 Temporal Carbonyl Results at Site B

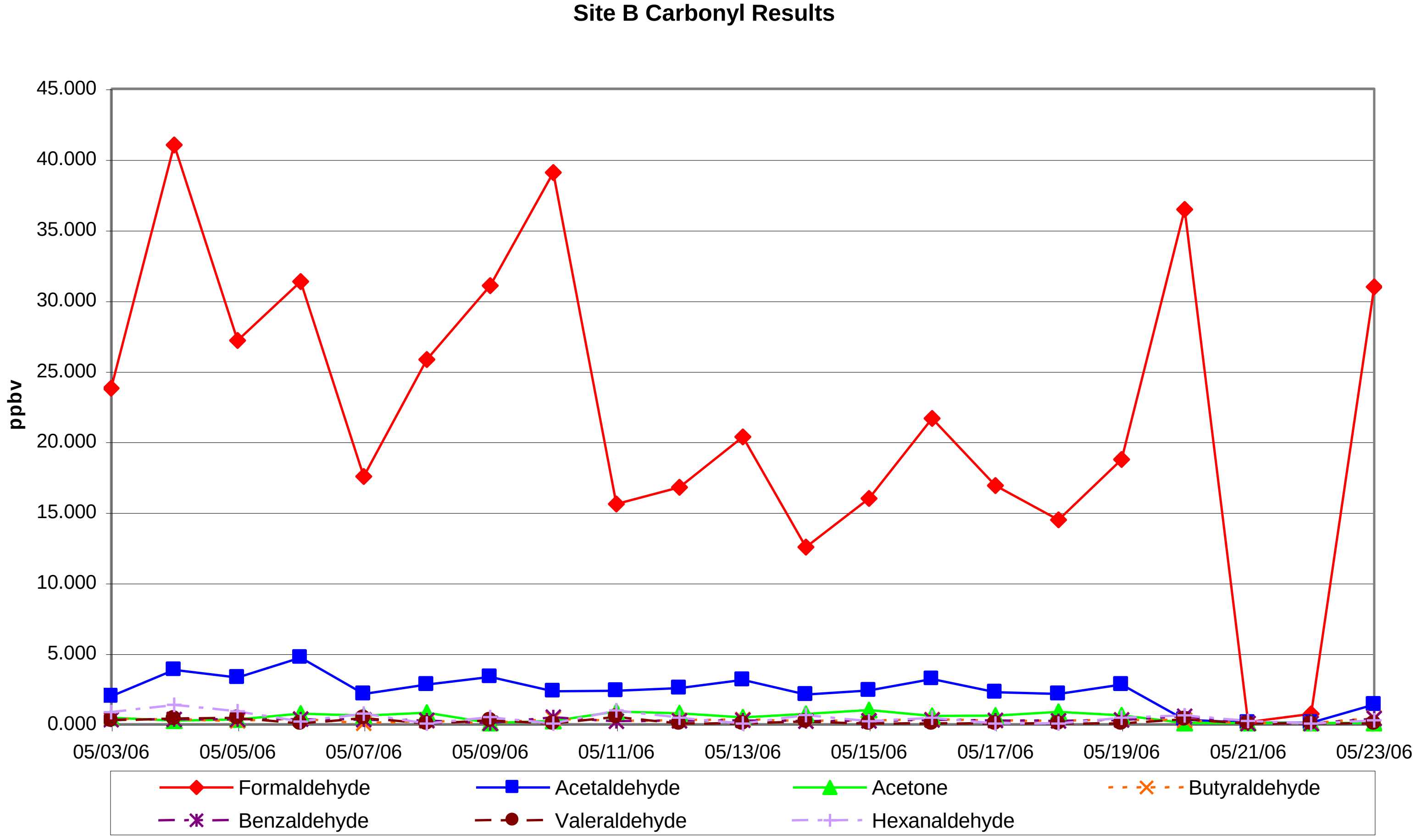


Figure 4.14 Temporal Carbonyl Results at Site C

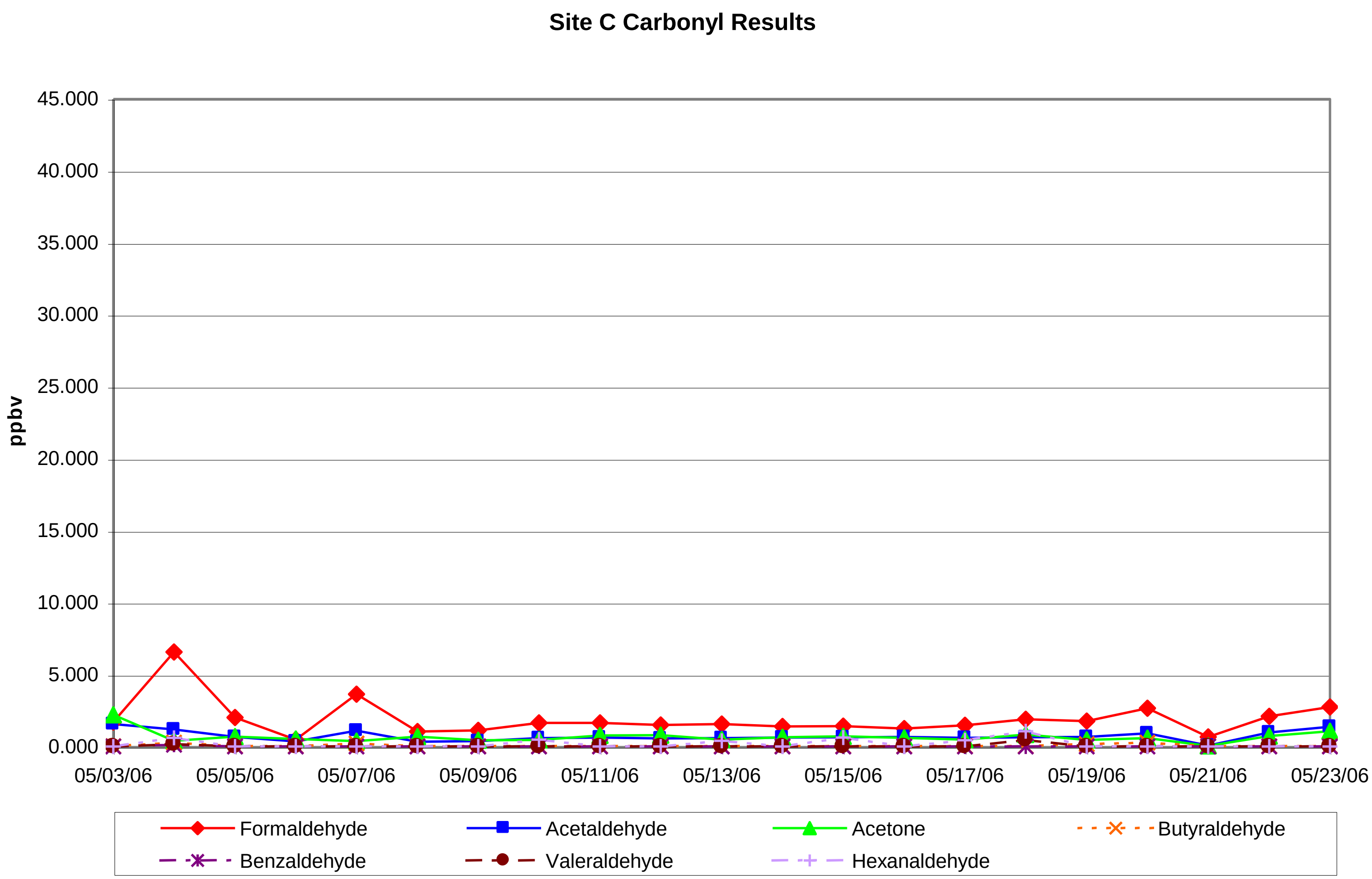


Table 4.4 compares carbonyl data for Sites A, B, and C to that collected during the month of May from 2002 to 2005 at the rural Candor UAT site (located in south central NC approximately 65 miles due east of Charlotte, NC). Inspection of the validated carbonyl data shows that Sites A, B, and C data are comparable to levels found in the rural air of Candor. Eastern Research Group (ERG), Research Triangle Park, NC, performed the extraction and analysis of the Candor UAT samples.

Table 4.4 Comparison Data for Sites A, B, C and the Candor UAT Site

	Site A (ppb) n=18		Site B (ppb) n=21		Site C (ppb) n=21		Candor UAT Month of May 2002-2005 n=6	
Compound	**Average**	**Max**	**Average**	**Max**	**Average**	**Max**	**Average**	**Max**
Formaldehyde	4.33	7.70	21.81	41.01	1.96	6.61	1.68	7.53
Acetaldehyde	0.92	2.40	2.34	4.71	0.75	1.61	0.64	1.79
Acetone	0.63	1.40	0.47	1.00	0.70	2.25	0.42	0.74
Propionaldehyde	0.14	0.38	0.23	0.37	0.03	0.31	0.10	0.33
Butyraldehyde	0.11	0.28	0.24	0.45	0.05	0.31	0.08[a]	0.17[a]
Benzaldehyde	0.12	0.82	0.27	0.56	0.01	0.17	0.03	0.10
Valeraldehyde	0.03	0.39	0.14	0.52	0.03	0.51	0.03	0.08
Isovaleraldehyde	<0.1	<0.1	0.09	0.32	0.06	0.39	0.05	0.06
m,p-Tolualdehyde	<.01	<0.1	0.01	0.23	0.01	0.25	-[b]	-[b]
Hexanaldehyde	0.12	1.30	0.42	1.36	0.18	1.09	0.04	0.13

a - The results for butyraldehyde for ERG is a combination of butyraldehyde and isobutyraldehyde
b - ERG provides a summation of all tolualdehydes

5.0 VOLATILE ORGANIC COMPOUNDS MONITORING

5.1 Method

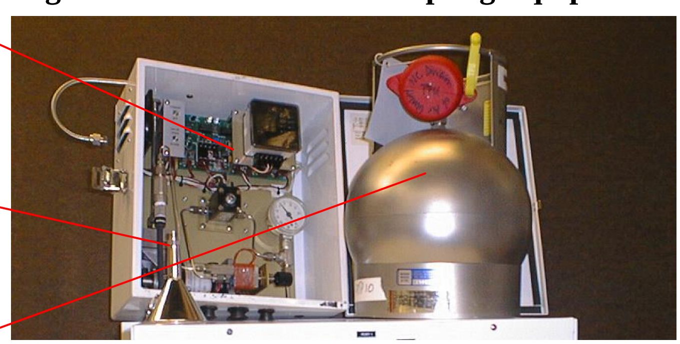
Volatile organic compound (VOC) samples were collected in 6 liter SUMMA® Canisters using XonTech® 911A canister samplers. An automatic timer on the 911A sampler was programmed to collect samples over a 24-hour period, beginning at 9:00 am daily. Sites A, B, and C were each equipped with two XonTech® 911A samplers operated on an alternating schedule in order to permit continuous sampling. Collected samples were sent under Chain of Custody (COC) to the TPB laboratory in Raleigh, NC for analysis. Sample analysis was performed following EPA Compendium Method TO-15, *Determination of VOCs in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography / Mass Spectroscopy (GC/MS),* EPA/625/R-96/010b. Samples were analyzed using a Varian 3800 gas chromatograph with a Saturn 2000 ion trap mass spectrometer and an Entech 7100 for sample preconcentration. The lower quantitation limit (LQL) for the instrumentation at the TPB laboratory is 0.2 ppbv. Measurements below the LQL are assigned a value of 0.5 times the LQL.

5.2 Sampling Period

Sampling occurred over a continuous 21-day period, May 3-23, 2006. Although sampling equipment failure caused a loss of 5 samples, the resulting field recovery rate was 92%.

5.3 Field Equipment

Figure 5.1 Photo of VOC Sampling Equipment

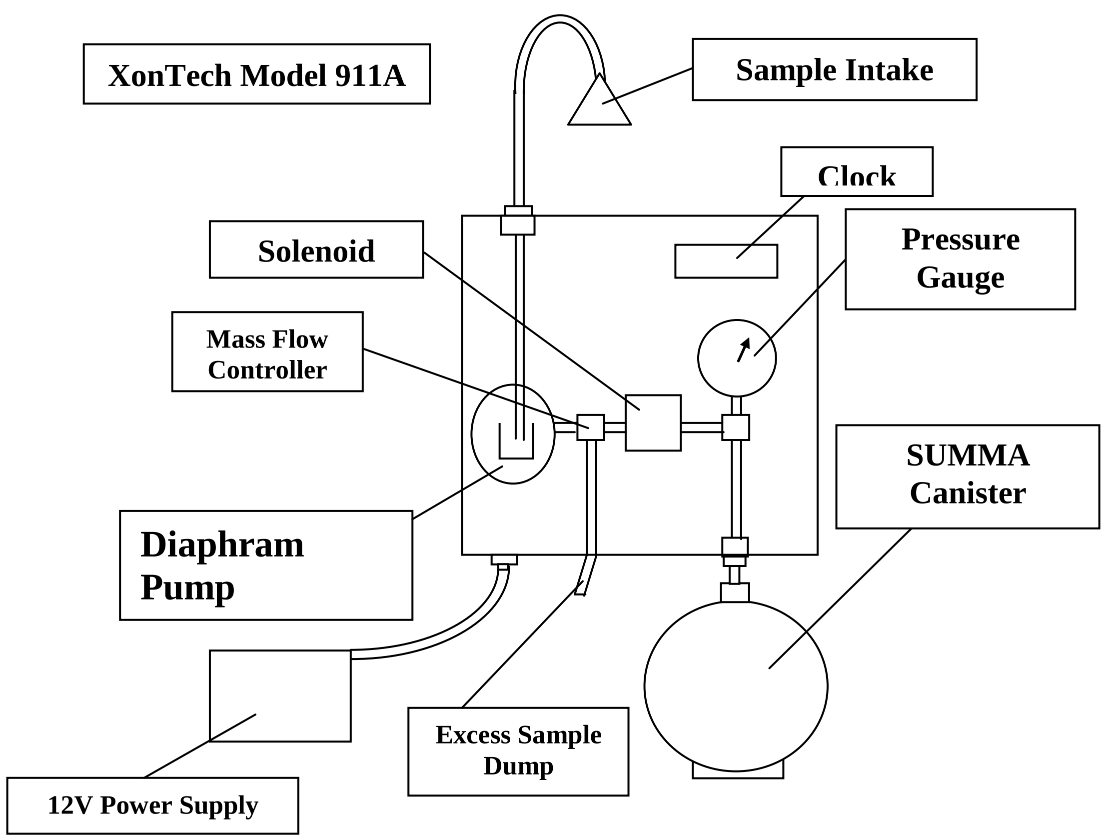


5.4 Sampling Procedure

Each VOC sampling site consisted of a sampling enclosure that housed the SUMMA® canisters, a Xontech™ 911A automated sampling system, and other sampling equipment for the study. Sampling equipment and lines were certified as clean before field deployment in accordance with internal TPB SOPs. Canisters were sealed with Chain of Custody (COC) seals and accompanied by paperwork during transport to and from the laboratory to prevent unauthorized tampering with the sample.

Figure 5.2 illustrates a typical sampler configuration. The sample inlet was mounted outside the sampling enclosure above the roof, approximately 10 feet above ground level. A stainless steel line extended from the sample inlet to the 911A sampler, and a clean SUMMA® canister was attached to the 911A sampler. The 911A pump was operated at a flow rate of 9 mL/min to collect the VOC sample over a period of 24 hours.

Figure 5.2 - Diagram of XonTech 911A System Configuration



5.5 Sample Analysis

A five point calibration (0.2, 0.5, 1.0, 2.5, and 10 ppbv) was performed before analysis with a successful calibration yielding a correlation coefficient of >0.99. Analytical check standards and blanks was run with each batch of analyzed samples. A 4-bromofluorobenzene (BFB) standard was also analyzed to ensure proper instrument performance.

Each sample was preconcentrated by removing water vapor and carbon dioxide using a purge and trap method. The concentrated sample was then injected onto the chromatographic column (Varian CP-Select 624CB, #CP7413, 60 meter, 0.25 mm I.D., 1.4μm film thickness) of a Varian 3800 gas chromatograph, with a Saturn 2000 ion trap mass spectrometer as a detector.

5.6 Data Results

Over the course of the study, 57 integrated samples were collected for VOC analysis: 20 samples at the Site A, 16 samples at Site B, and 21 samples at Site C. The average and maximum concentration for each VOC detected above 0.2 ppbv is summarized in Table 5.1. Table 5.2 shows VOCs that were not detected above 0.2 ppbv at any site. The annual averages and maximum values from the Candor UAT site, May 2004/2005 are shown for comparison. Sampling was conducted at Sites A, B, and C using identical sampling equipment and protocols except that UAT samples are collected every 6^{th} day, and from midnight to midnight. Values below the LQL are indicated by a dash in the table. Only data meeting the QA/QC criteria are used; and data below the LQL of 0.2 ppb are assigned a value of 0.5 times the LQL for statistical evaluation purposes.

Table 5.1 Results from Sites A, B, C and Candor UAT Site for Comparison

VOC	Candor UAT May 2005 & 2006 (n=9)		Site A (n=20)		Site B (n=16)		Site C (n=21)	
	Average	Max	Average	Max	Average	Max	Average	Max
Freon 12	0.58	0.69	0.64	0.69	0.65	0.75	0.61	0.68
Methyl chloride	0.51	1.08	0.36	0.84	0.37	0.98	0.37	0.97
Bromomethane	-	-	-	-	-	-	-	0.52
Ethanol	-	-	0.91	3.974	-	-	0.32	1.32
Freon 11	0.24	0.49	0.40	1.20	1.05*	7.96	0.39	1.16
Methylene chloride	0.11	0.22	-	0.67	-	-	-	-
Carbon disulfide	0.14	0.31	0.12	0.20	0.14	0.40	0.12	0.24
Hexane	-	-	-	0.28	-	0.24	-	0.22
Benzene	0.17	0.30	0.32	0.43	0.34	0.41	0.36	0.76
Heptane	-	-	-	0.22	-	-	-	-
Toluene	-	-	0.76	1.85	0.47	0.67	0.46	0.89
Ethylbenzene	-	-	-	0.38	-	-	-	-
m- & p-Xylene	-	-	0.35	0.91	0.22	0.44	0.24	0.62
o-Xylene	-	-	-	0.30	-	-	-	0.21
1-Ethyl-4-methyl benzene	-	-	-	0.23	-	-	-	-

1) Dashes represent values of 0.1ppbv.
2) Values in the data sets that were below 0.2 ppbv were assigned values of 0.1 ppbv for statistical purposes.
* suspected air conditioner refrigerant leak at site B sampling enclosure.

Table 5.2 Compounds Not Detected Above 0.2 ppbv

Freon 114	Methyl tertiary butyl ether	cis-1,3 Dichloropropene	1,2-Dibromoethane
Vinyl chloride	cis-1,2 Dichloroethene	Methyl isobutyl ketone	Chlorobenzene
1,1-Dichloroethene	Chloroform	trans-1,3 Dichloropropene	Bromoform
Freon 113	1,2-Dichloroethane	1,1,2-Trichloroethane	1,1,2,2-Tetrachloroethane
trans-1,2 Dichloroethene	1,2 Dichloropropane	Dibromochloromethane	Hexachlorobutadiene
1,1-Dichloroethane	Isopropyl alcohol	Carbon tetrachloride	Tetrachloroethylene
1,3-Butadiene	1,1,1-Trichloroethane	Cyclohexane	1,3,5-Trimethyl-benzene
Trichloroethylene	Tetrahydrofuran		

In Table 5.1, it is observed that the average VOC concentrations across sites are similar. Additionally, the comparison of Sites A, B, and C to the rural Candor UAT site (data for May 2005/2006) indicates that VOC concentrations are elevated in those VOCs such as benzene, toluene, and xylenes, that are emitted by mobile sources that tend to be concentrated in urban areas.

Note: In Table 5.1, tetrahydrofuran was not reported and it was found in unexpectedly elevated levels at the Site C. The source of this compound was attributed to the TPB on-site laboratory, in which tetrahydrofuran was used as a reagent for carbonyl analysis. It is assumed that fugitive emissions from the laboratory were sampled at the Site C because the sampling apparatus was *located on the roof of the laboratory trailer. Tetrahydrofuran was not detected in samples from the Sites A or B. The laboratory did not contain nor emit other TO-15 VOCs or other compounds of interest in this study.*

6.0 MERCURY MONITORING

6.1 Analytical Instrumentation and Operating Procedures

6.1.1 Mercury Vapor Analyzer

Continuous measurement of Total Gaseous Mercury (TGM) was performed using Tekran Model 2537A mercury vapor analyzers (Figure 6.1). These instruments allow for sub-nanogram per cubic meter (ng/m^3) analysis of mercury in air by trapping mercury vapor on an ultra-pure gold adsorbent, then thermally desorbing the trapped mercury for measurement by Cold Vapor Atomic Fluorescence Spectrometry (CVAFS).

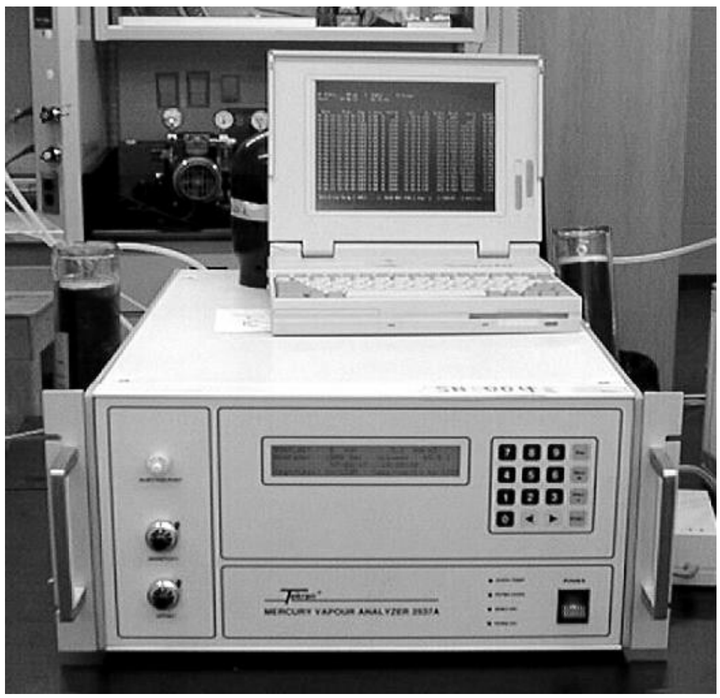


Figure 6.1: Tekran 2537A Mercury Vapor Monitor.

The reported detection limit for this instrument is 0.1 ng/m^3, far below normal ambient air mercury levels in NC, which are typically 1-2 ng/m^3. The dual cartridge design allows for continuous monitoring by alternating mercury sampling and desorption measurement. Ambient air was drawn through ¼-inch heated Teflon tubing containing two 0.2 μm particulate filters in the sample line. The instruments were programmed to provide mercury measurements at 5 minute intervals at each sampling site and during periods when the Tekran Model 1130 Mercury Speciation Unit (see next section for detailed description) was not in use. The sample flow rate was set at 1.0 L/min. Sample lines were fed through ports located in the ceiling or sides of the sampling enclosures. TGM sample intakes were positioned at a height of approximately three meters above ground, away from the roof of the enclosures.

6.1.2 Mercury Speciation Unit

Continuous measurement of Reactive Gaseous Mercury (RGM) and elemental mercury vapor ($Hg^{(0)}$) was carried out using a Tekran Model 1130 Mercury Speciation Unit. The mercury speciation unit is a front-end unit that allows the Tekran 2537A to differentiate between elemental and reactive gaseous mercury species (Figure 6.2). The instrument collects RGM by sampling ambient air through a potassium chloride-coated (KCl) quartz denuder which, after a predetermined sampling period, is then heated to liberate RGM captured on the denuder surface as $Hg^{(0)}$. $Hg^{(0)}$ is then transported by a zero air flush to the analytical instrumentation for measurement by CVAFS. During the time that the speciation unit is collecting RGM, the Tekran 2537A unit continues to monitor $Hg^{(0)}$ as it passes unimpeded through the denuder to be analyzed as described earlier.

The mercury speciation unit intake was located at a height of approximately 3.5 meters above ground. The denuder system was housed in a weatherproof, temperature-controlled enclosure. A heated sample line connects the denuder module to the system pump. A 1.0 μm quartz filter was installed at the intake of the sample line. The configuration of the mercury vapor analyzer inside the trailer was identical to specifications described above.

Figure 6.2: Tekran Model 1130 Mercury Speciation Unit.

The mercury speciation system was programmed to provide continuous readings for gaseous $Hg^{(0)}$ at 5-minute intervals using a flow rate of 10 L/min air across the denuder and 1.0 L/min air to the mercury vapor analyzer. After one hour of sampling, analysis of $Hg^{(0)}$ stopped and the system automatically switched to RGM analysis. Zero air was flushed through the denuder and sample line. The denuder was then heated, liberating captured RGM and converting it to elemental mercury for delivery to the gold cartridge trap. Calculated concentrations for RGM represent 1-hour averages.

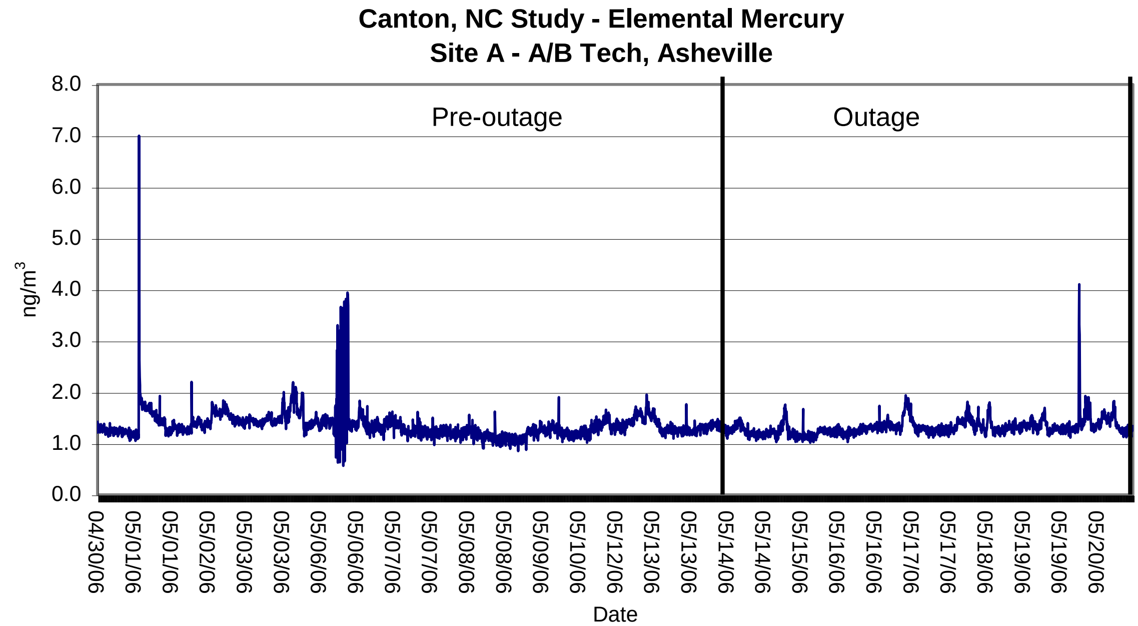
6.2 Data Results

Data results for elemental mercury vapor will be presented by sampling site. How these results relate to each other and characterize the study area as a whole will be discussed in the Conclusions and Discussions Section. No monitor was located at Site B because the site was found to have been the site of a prior mercury spill. The site was reported to be decontaminated, however if a monitor had been located at this site, due to the high sensitivity of the instrument, measured concentrations could have been confounded by residual mercury from the spill.

6.2.1 Site A

TGM sampling at Site A occurred April 30 - May 20, 2006. The average measured concentration at Site A was 1.3 ng/m^3 with a standard deviation of 0.25 ng/m^3. The median was 1.3 ng/m^3. TGM is the sum of the $Hg^{(0)}$ and RGM; however, because historical sampling data indicates that RGM is typically 3 orders of magnitude lower than the concentration of $Hg^{(0)}$, for practical purposes TGM is equal to $Hg^{(0)}$. This relationship was also observed in data collected at Site C.

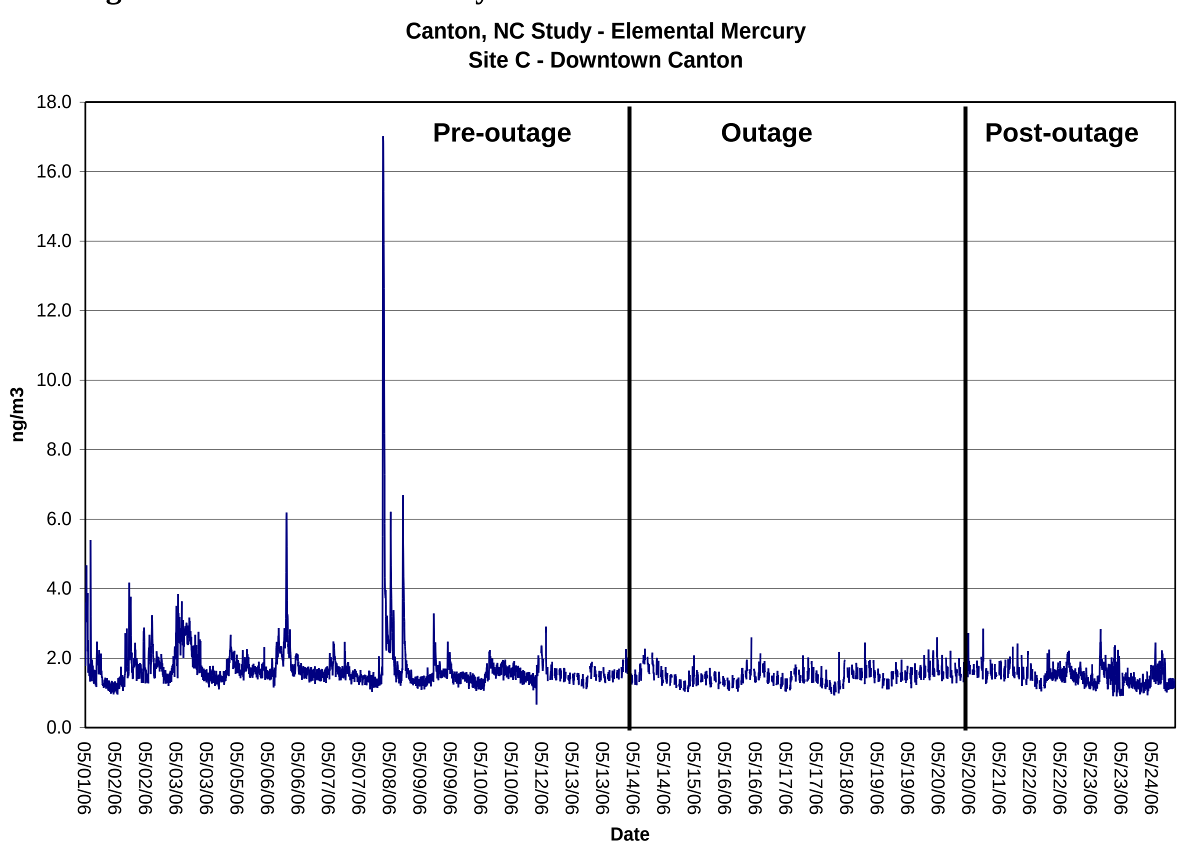
Figure 6.3 Total Gaseous Mercury at Site A



6.2.2 Site C

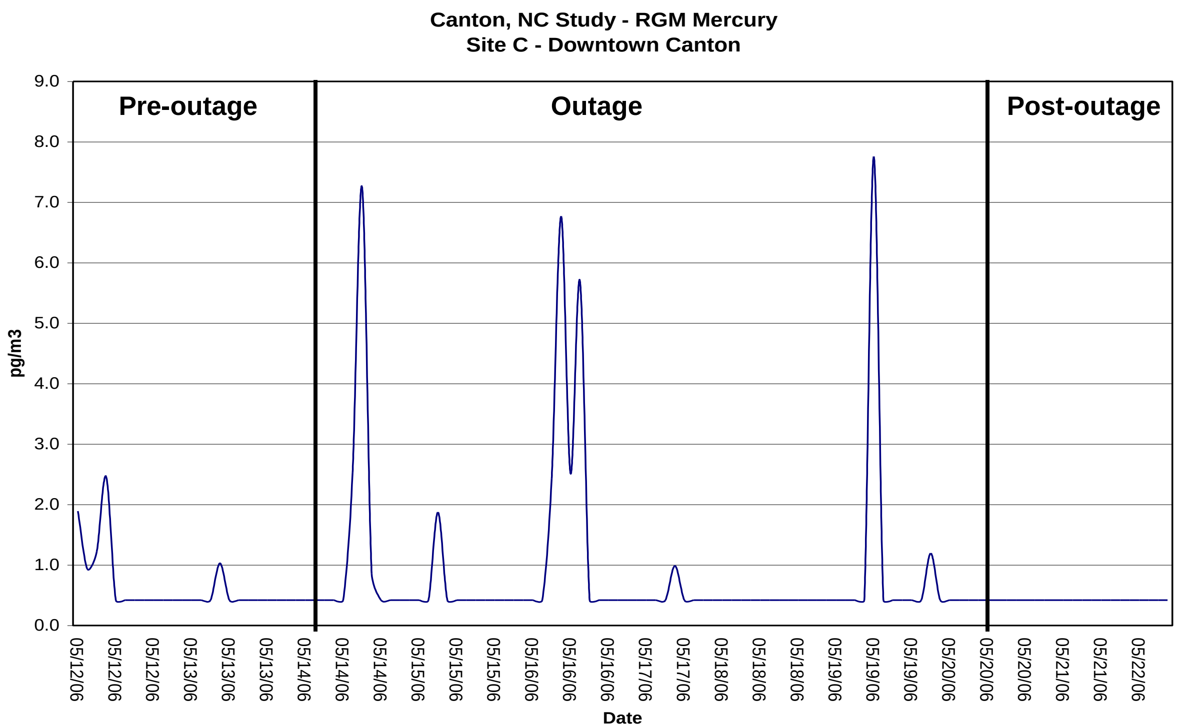
Monitoring for elemental mercury at Site C was conducted May 1–24, 2006. The data are presented as 5-minute averages. The average concentration was 1.6 ng/m^3 with a standard deviation of 0.72 ng/m^3. The median was 1.5 ng/m^3.

Figure 6.4 Elemental Mercury at Site C



RGM and particulate bound mercury (PBM) sampling were performed May 12-22, 2006. Results for these are reported as 1-hour averages. The average particulate concentration was 0.44 pg/m^3 with a standard deviation of 0.36 pg/m^3. The median was 0.41 pg/m^3. The average RGM concentration was 0.78 pg/m^3 with a standard deviation of 1.3 pg/m^3. The median was 0.42 pg/m^3. The average for the RGM was actually below the method detection limit (MDL) of 0.82 pg/m^3. As stated earlier, all values below the MDL were reported as half that, or 0.41 pg/m^3. Of the RGM samples collected, the maximum concentration was 7.8 pg/m^3.

Figure 6.5 Reactive Gaseous Mercury at Site C



6.3 Data Summary

Table 6.1 Mercury Monitoring Summary

Site	Type	Mean Conc. (ng/m^3)	Median Conc. (ng/m^3)	Maximum Conc. (ng/m^3)
A	TGM	1.3	1.3	7.9
C	RGM	4.1×10^{-4}	4.1×10^{-4}	7.8×10^{-3}
C	$Hg^{(0)}$	1.6	1.5	17
C	PBM	4.0×10^{-4}	4.0×10^{-4}	1.6×10^{-3}

The predominant species of mercury in ambient air is $Hg^{(0)}$. This is demonstrated by examining Table 6.1 where $Hg^{(0)}$ concentration is 4 orders of magnitude greater than RGM and PBM concentrations. It is a generally accepted rule of thumb that the average background $Hg^{(0)}$ concentration is between 1 and 2 ng/m^3. Sampling data collected at Sites A and C are within this range and therefore are not considered to be different from background.

7.0 Reduced Sulfur Compounds (RSC) Monitoring

7.1 Method

RSC samples were collected in 6 liter SilcoSteel ® Canisters using restricted orifice samplers. Samples were integrated over a 24-hour collection period, beginning and ending at 9:00 am daily and sent under Chain of Custody (COC) as UPS overnight delivery to Air Toxics Ltd., Folsom, CA for analysis. Upon arrival at Air Toxics Ltd., the samples were pressurized and analyzed within 5 days of receipt. Pressurization was accomplished by adding ultra-pure nitrogen to the canister. Dilution factors, used to calculate a lower quantitation limit (LQL) for each sample, were then determined based on the volume of pressurization gas added. In general, the LQLs were 4-9 ppb for RSCs. Samples were analyzed using ASTM Method D-5504 using a gas chromatograph with a sulfur chemiluminescence detector (GC/SCD). Air Toxics Ltd. analyzed each sample for the compounds listed in Table 7.1. One of the reduced sulfur compounds in Table 7.1 is "Total Reduced Sulfur." Its concentration is determined by summing the areas under all chromatographic peaks not otherwise identified as one of the 20 specific sulfur compounds listed in Table 7.1.

Table 7.1 Reduced Sulfur Compounds

Hydrogen Sulfide	Carbon Disulfide	Thiophene	3-Methylthiophene
Carbonyl Sulfide	Isopropyl Mercaptan	Isobutyl Mercaptan	Tetrahydrothiophene
Methyl Mercaptan	tert-Butyl Mercaptan	Diethyl Sulfide	2-Ethylthiophene
Ethyl Mercaptan	n-Propyl Mercaptan	n-Butyl Mercaptan	2,5-Dimethylthiophene
Dimethyl Sulfide	Ethyl Methyl Sulfide	Dimethyl Disulfide	Diethyl Disulfide
Total Reduced Sulfur			

7.2 Sampling Period

Sampling was performed continuously at Sites B and C during May 8-23, 2006. Sampling at Site A was conducted May 8-11 and May 19-23, 2006. Daily sampling was not done at Site A due to resource limitations. RSC monitoring was focused on Sites B and C.

7.3 Sampling Procedure

The canisters and restricted orifices were certified as clean before deployment using internal TPB SOPs. Canister samples were sealed under Chain of Custody (COC) and accompanied by appropriate paperwork during transport to and from the laboratory to prevent unauthorized tampering with the sample. One SilcoSteel ® coated restricted orifice assembly was provided for each site and was exchanged between canisters for sampling.

A typical sampling assembly is shown in Figure 7.1. For sampling, the assembly is secured to the railing on the roof of the sampling enclosure. The valve is opened and allowed to remain open during the sampling period. On completion of sampling, the valve is closed and sample sent under COC to the laboratory for analysis.

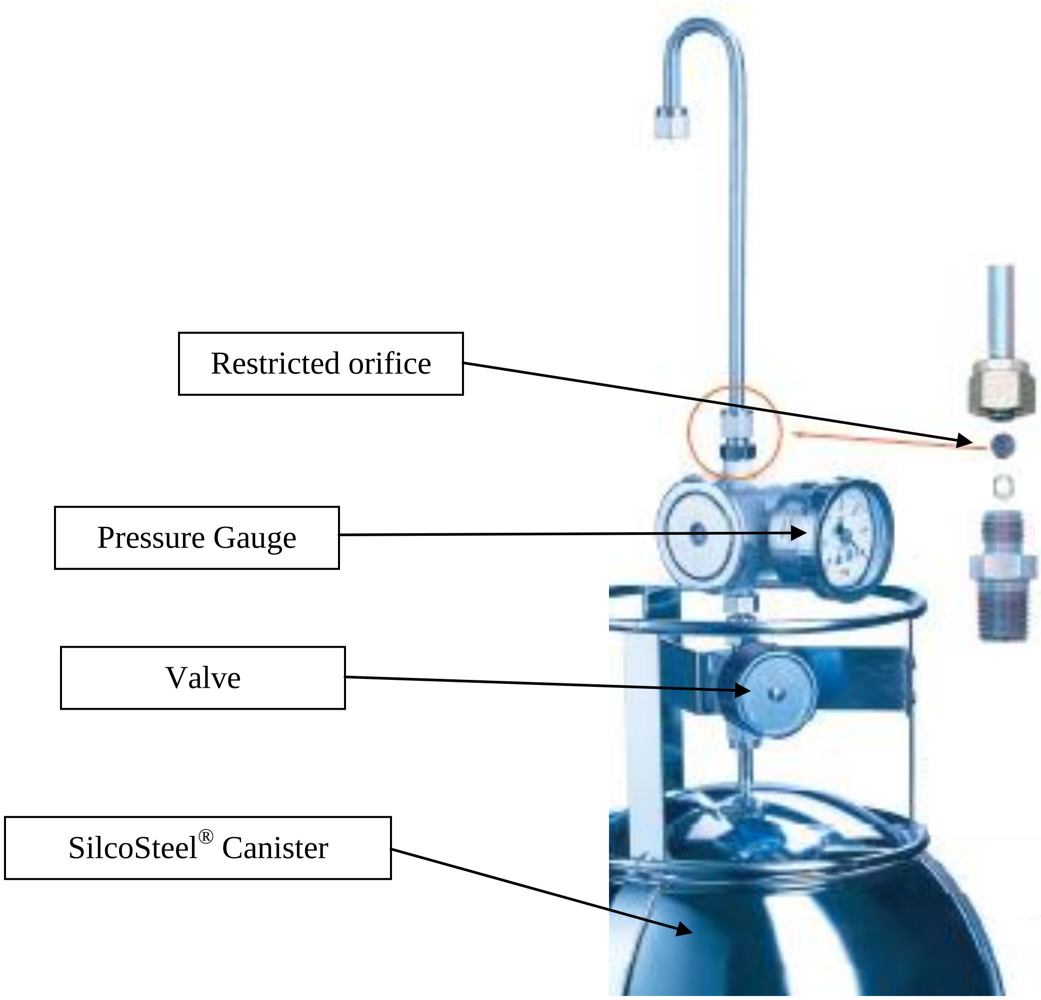


Figure 7.1 SilcoSteel® Canister and Restricted Orifice Sampling Train

7.4 Data Results

During the study, 9 samples were collected at Site A, 14 samples at Site B, and 15 samples at Site C. The results are given in Table 7.2. Blank cells represent values that are below the lower detection limit in air (LDL, in column 3 of the Table) for that sample.

Table 7.2 RSC Data Concentration, ppbv		**LDL (ppbv)**	**Hydrogen Sulfide**	**Carbonyl Sulfide**	**Methyl Mercaptan**	**Ethyl Mercaptan**	**Dimethyl Sulfide**	**Carbon Disulfide**	**Isopropyl Mercaptan**	**tert-Butyl Mercaptan**	**n-Propyl Mercaptan**	**Ethyl Methyl Sulfide**	**Thiophene**	**Isobutyl Mercaptan**	**Diethyl Sulfide**	**n-Butyl Mercaptan**	**Dimethyl Disulfide**	**3-Methylthiophene**	**Tetrahydrothiophene**	**2-Ethylthiophene**	**2,5-Dimethylthiophene**	**Diethyl Disulfide**	**Total Reduced Sulfur**
Odor Threshold (ppb)			**0.5 (1)**	**55 (2)**	**0.02 (1)**	**0.013 (1)**	**0.98 (1)**	**7.8 (1)**	**6 x 10^{-3} (2)**	**2.9 x 10^{-3} (2)**	**0.064 (1)**	**15.7 (1)**	**0.76 (1)**	**0.54 (1)**	**7.0 (1)**	**0.43 (1)**	**0.026 (1)**	**No Data**	**0.62 (2)**	**No Data**	**No Data**	**2 x 10^{-3} (2)**	
Sample ID Site A	**Lab ID #**																						
S050806A	0605223-01A	6.6																					
S050906A	0605270-01A	6.4																					
S051006A	0606310-01A	6.6																					
S051106A	0605334-01A	6.7																				11.0	220.0
S051206A	Not sampled																						
S051306A	Not sampled																						
S051406A	Not sampled																						
S051506A	Not sampled																						
S051606A	Not sampled																						
S051706A	Not sampled																						
S051806A	Not sampled																						
S051906A	0605532-01A	6.7																					
S052006A	0605536-01A	6.8																					
S052106A	0605538-01A	6.6																					
S052206A	0605561-01A	6.7																					
S052306A	0605599-01A	6.6																					
Site B	**Lab ID #**																						
S050806B	0605225-01B	8.7																					
S050906B	0605269-01B	8.9																					
S051006B	Sampling error																						
S051106B	0605336-01B	8.5																					58.0
S051206B	Sampling error																						
S051306B	0605376-01B	8.9																					
S051406B	0605382-01B	8.9																					

Table 7.2 RSC Data Concentration, ppbv		**LDL (ppbv)**	**Hydrogen Sulfide**	**Carbonyl Sulfide**	**Methyl Mercaptan**	**Ethyl Mercaptan**	**Dimethyl Sulfide**	**Carbon Disulfide**	**Isopropyl Mercaptan**	**tert-Butyl Mercaptan**	**n-Propyl Mercaptan**	**Ethyl Methyl Sulfide**	**Thiophene**	**Isobutyl Mercaptan**	**Diethyl Sulfide**	**n-Butyl Mercaptan**	**Dimethyl Disulfide**	**3-Methylthiophene**	**Tetrahydrothiophene**	**2-Ethylthiophene**	**2,5-Dimethylthiophene**	**Diethyl Disulfide**	**Total Reduced Sulfur**
Odor Threshold (ppb)			**0.5 (1)**	**55 (2)**	**0.02 (1)**	**0.013 (1)**	**0.98 (1)**	**7.8 (1)**	**6×10^{-3} (2)**	**2.9×10^{-3} (2)**	**0.064 (1)**	**15.7 (1)**	**0.76 (1)**	**0.54 (1)**	**7.0 (1)**	**0.43 (1)**	**0.026 (1)**	**No Data**	**0.62 (2)**	**No Data**	**No Data**	**2×10^{-3} (2)**	
Site B	**Lab ID #**																						
S051506B	0605418-01B	9.2																					
S051606B	0605427-01B	9.2																					
S051706B	0605456-01B	9.4																					
S051806B	0605490-01B	8.9																					
S051906B	0605533-01B	9.8																					
S052006B	0605537-01B	10.0																					
S052106B	0605540-01B	9.8																					
S052206B	0605562-01B	6.0																					
S052306B	0605591-01B	9.2																					
Site C	**Lab ID #**																						
S050806C	0605224-01C	7.3																					
S050906C	Sampling error																						
S051006C	0605312-01C	7.6																					
S051106C	0605337-01C	7.3																					
S051206C	0605338-01C	7.3																					
S051306C	0605377-01C	7.5																					
S051406C	0605383-01C	7.3																					
S051506C	0605428-01C	7.3																					12.0
S051606C	0605426-01C	7.5																					
S051706C	0605457-01C	7.8																					16.0
S051806C	0605489-01C	7.5																					
S051906C	0605534-01C	7.8																					
S052006C	0605535-01C	8.0																					
S052106C	0605539-01C	7.6																					
S052206C	0605563-01C	7.0																					
S052306C	0605597-01C	7.5																					

(1) Ruth, J.H., "Odor Thresholds and Irritation Levels of Several Chemical Substances: A Review," **Am. Ind. Hyg. Assoc. J.**, 47:A-142 – A151, March 1986

(2) Nagata, Yoshio, "Measurement of Odor Threshold by Triangular Odor Bag Method," **Odor Measurement Review**, 118-127, 2003. Accessed on July 30, 2007 at: http://www.env.go.jp/en/air/odor/olfactory_mm/04ref_2.pdf

From the data in Table 7.2, it is evident that people with normal olfactory response could detect odors resulting from emissions of RSCs, while sampling for those same compounds yielded less than detectable airborne concentrations. Only carbonyl sulfide, carbon disulfide, ethyl methyl sulfide, and diethyl sulfide have olfactory thresholds greater than the detection limits for the monitoring method. Otherwise unidentified TRS compounds can produce an unpleasant olfactory response, and RSCs are not the only compounds that produce such a response.

The wind rose for the RSC sample collected at Site A during May 11-12, 2006 shows that the wind was predominantly from the NNW/NW quadrant. Upwind of Site B is the Asheville-Buncombe Technical Community College Maintenance Shop as well as the general downtown area of the city of Asheville. A more specific source for the RSCs collected in this sample could not be delineated.

The wind rose for the RSC sample collected at Site B for May 11-12, 2006 shows wind patterns that were predominantly from the WSW and SW quadrant. In this direction from Site B is the BRPP rail yard and WWTP. During this time period, the facility was operating under normal conditions before the scheduled outage. Either or both the rail yard or WWTP could be the source of the RSCs collected in this sample. While it is more likely that the WWTP was the origin, source apportionment from such a restricted data set is inappropriate.

The wind rose for the RSC sample collected at Site C for May 15-16, 2006 shows wind speeds between 2-10 mph for the majority of the sample collection time and wind direction ranging from the WNW to the SE. This change in wind direction during the day is more easily seen in Figure 7.2 below. As can be seen in the figure, the winds ranged from the WNW quadrant (270° to 300°) through the SW directions (225°) to the S (180°) and SE directions (135°) and back towards the west. The shutdown of the foul condensate stripper began at 7:30 am May 15 and for at least the first 12 hours of the outage Site C was downwind of the WWTP, where foul condensate stripper effluent was being shunted. This might indicate that this was the source of the RSCs detected in this sample given that this is the most likely source of such compounds in the vicinity.

Figure 7.2 Wind Data from May 15-16, 2006 (9am – 9am)

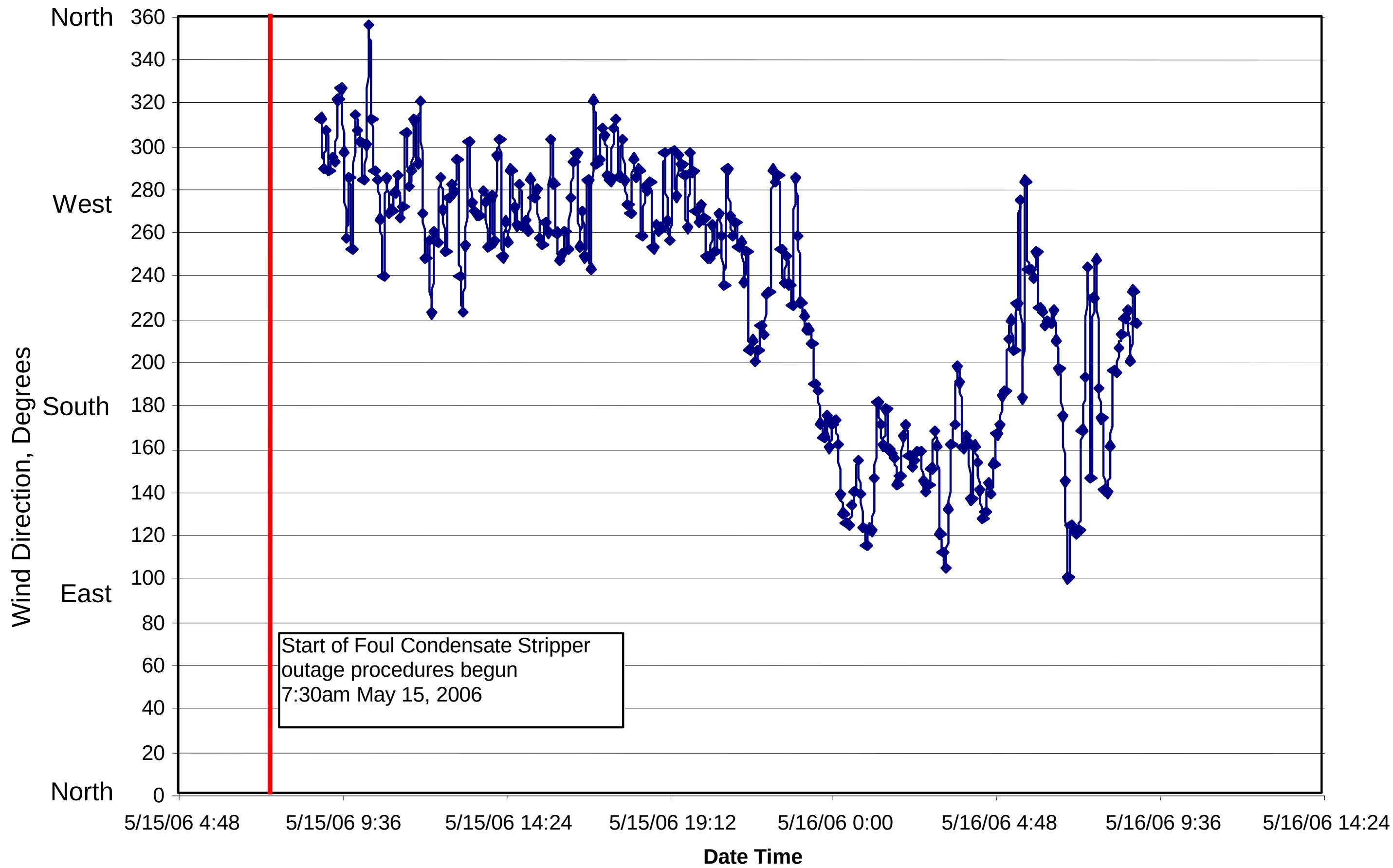
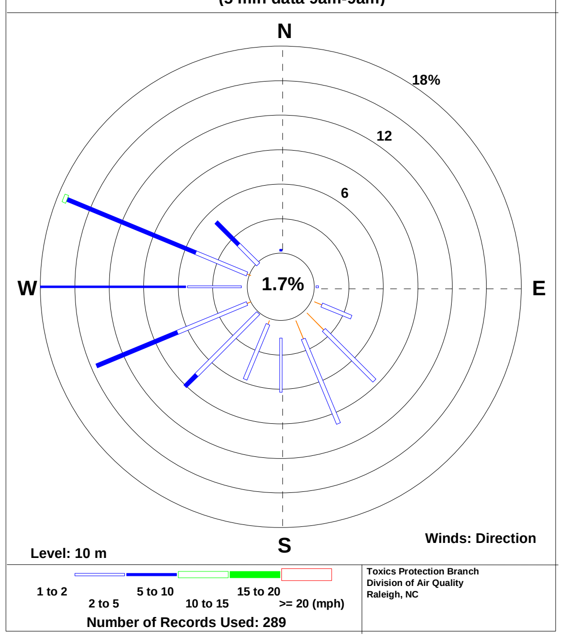


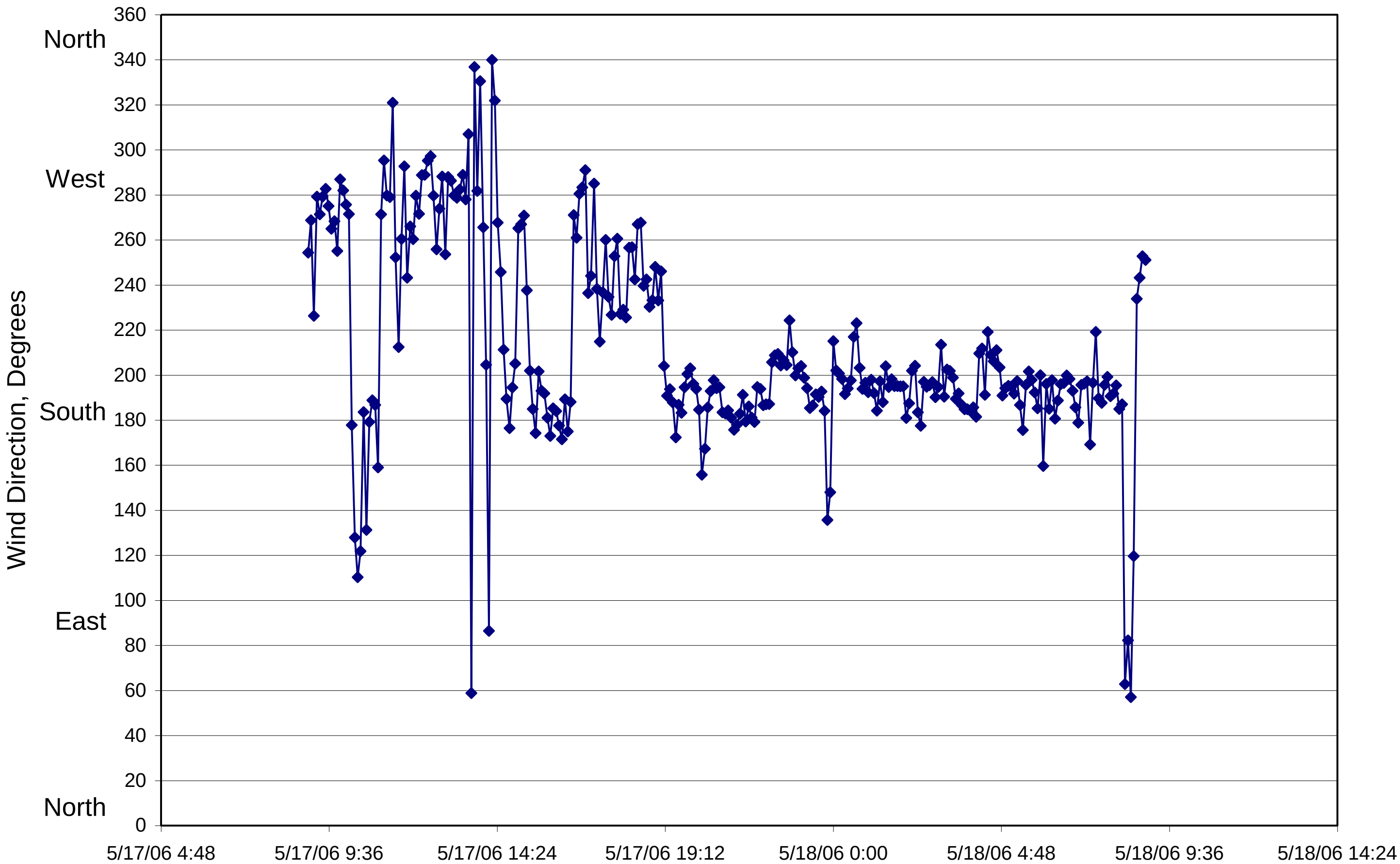
Figure 3.37 Canton Windrose Site B and C (data
May 15, 2006 through May 16, 2006
(5 min data 9am-9am)



The wind rose for the RSC sample collected at Site C for May 17-18, 2006 shows wind speeds that were between 2-10 mph for the majority of the sample collection time and wind direction that ranged from W to S. This change in wind direction during the day is more easily seen in Figure 7.3 below. As can be seen in the figures, the winds ranged from the W quadrant (260° to 280°) through the SW directions (225°) to the S (180°) and SE directions (135°). The shutdown of the foul condensate stripper was continued on this day and winds were at times from the general direction of the WWTP (westerly) during first ten hours or so of the sampling period, but the remainder of the sampling period the winds were from the south. The variation in the wind to the south, a direction from which there is no known source for RSCs other than perhaps motor vehicles indicates that the RSCs observed may have come from the WWTP or other facility source during the time the winds were from the westerly directions.

It should also be noted that there were other sampling periods throughout the study when the winds were from the direction of the facility and its WWTP when no reduced sulfur compounds were detected in the samples. However, when they were detected at Sites B and C, there was a component of the wind direction for some portion of the sample period that could have transported air from the WWTP or other facility source to the sites. This observation also supports reports that odors at times are transient in nature.

Figure 7.3 Wind Data from May 17-18, 2006 (9am – 9am)



8.0 RISK ASSESSMENT OF STUDY DATA

8.1 Introduction

The purpose of this monitoring study was to assess odor and air quality in Canton, NC. The study was conducted in response to a request from the Asheville Regional Office of the NC Division of Air Quality after the regional office had received complaints of odors allegedly from the Blue Ridge Paper Products (BRPP) facility in Canton. The conclusions of the study have been stated in earlier sections of this report. In addition, these sampling data were used to evaluate the magnitude of risk of exposure of the general public to these airborne chemicals. In this regard, only the inhalation pathway was investigated. There may be additional risks due to other pathways, like ingestion or absorption.

There were several questions for which answers were needed:

1. Of the compounds that were sampled during this study, which are "compounds of potential concern (COPCs)?"
2. What is the cancer risk to the general public through inhalation exposure to these air toxics?
3. What is the non-cancer health risk posed by inhalation exposure of the general public to these air toxics?
4. If risk is elevated, what organs or organ systems are impacted?

It is important to note that sampling was done before, during, and after a 21-day maintenance period and partial system shutdown at BRPP during May 2006. *Because of this, conclusions inferred from the assumptions made and the extrapolations of these data to annual average concentrations (to evaluate chronic and cancer risks), or to "equivalent one-hour concentrations" (to evaluate acute risks), which were utilized for the purposes of this risk assessment, could have <u>large</u> amounts of associated uncertainty.*

8.2 Methodology

Data acquired by sampling for ammonia, mercury and mercury compounds, carbonyl compounds, RSCs, and VOCs were used for risk assessment purposes. Only quality assured data that were equal to or exceeded 15% of the number of days sampled were used in the assessment.

Sample mean, standard deviation, minimum and maximum values for each compound were determined.

To evaluate risk resulting from acute exposure, a short-term airborne concentration and an acute comparative risk level (CRL) are needed. The sampling data for ammonia and mercury (and mercury compounds) are continuous or nearly so, and can be used directly to estimate acute risk. The data for carbonyls, VOCs, and RSCs are for 24-hour integrated samples. By transforming these integrated samples into equivalent 1-hour concentrations, the potential risk from acute exposure can be evaluated. The transformation is performed using the following equation:

$$1hr\ Equivalent\ Concentration\left(\frac{\mu g}{m^3}\right)=\left(24hr\ Exposure\,Concentration,\frac{\mu g}{m^3}\right)\times 24hr$$

This “equivalent concentration” results in a “worst-case” approximation that is, in all likelihood, an overestimation (perhaps a gross overestimation) of acute exposure. However, it could prove helpful in an evaluation of potential acute effects. A Hazard Quotient (HQ) can then be determined for each 1hr equivalent concentration by dividing that equivalent concentration by an appropriate Comparative Risk Level (CRL):

$$HQ_{acute}=\frac{Equivalent\ 1hr\ Concentration\left(\frac{\mu g}{m^3}\right)}{CRL_{acute}\left(\frac{\mu g}{m^3}\right)}$$

A Hazard Quotient (HQ) is a ratio of exposure concentration to a benchmark inhalation reference concentration – an exposure concentration at or below which no adverse non-cancer health effects are likely to occur. Hazard Quotients are not expressed as probabilities of disease occurrence; HQs less than or equal to 1 indicate that non-cancer health effects resulting from exposure to that contaminant are not likely to occur.

CRLs are peer-reviewed, published benchmark exposure concentrations. For this study, CRLs were prioritized from various sources:

Table 8.1 CRL Priorities and Sources

Priority	Acute	Chronic	Cancer
1	NC AAL	NC AAL	NC AAL
2	AEGL-1 (1hr)	EPA IRIS	EPA IRIS
3	ERPG-1	ATSDR MRL	CA OEHHA
4	ATSDR MRL	CA OEHHA	

where:

NC AAL: North Carolina Acceptable Ambient Levels [1]

AEGL –1 (1 hr): Acute Exposure Guideline Levels, developed by the Committee on Toxicology of the National Research Council [2]

ERPG – 1: Emergency Response Planning Guidelines, developed by the ERPG Committee of the American Industrial Hygiene Association [3]

CA OEHHA: California Office of Environmental Health Hazard Assessment [4]

If a CRL (with an appropriate averaging time) was not available from the Priority 1 CRL source, then the Priority 2 source was used, then Priority 3, then Priority 4. If no CRL was found in any of the sources, then the HQ for that air toxic was not determined.

Once HQs were determined for all sampled contaminants having a CRL, Hazard Indexes were determined by summing the appropriate Hazard Quotients:

$$HI_{chronic} = \sum_i HQ_{i\ chronic}$$

$$HI_{acute} = \sum_i HQ_{i\ acute}$$

People are generally exposed to a complex mixture of air pollutants, the individual toxicological responses to which are unknown. For evaluative purposes, however, this mixture is treated as interacting additively; that is, the total toxicological response is the sum of the individual responses to the components of the mixture. It is recognized that this is simplistic; it is not toxicologically plausible that different pollutants with different toxic effects can be summed; it is used merely as a screen. This summed toxicological response is called the Hazard Index (HI).

Sites with an HI greater than 1 should be further evaluated by examining the critical toxic effect(s) of each pollutant on specific target organs in humans, a TOSHI analysis.

HQs and HIs for chronic exposures were determined in the same manner as those for acute exposures, except that the average exposure concentration over the entire sampling campaign was used as if it was the annualized average exposure concentration. Chronic CRLs were used.

$$HQ_{chronic} = \frac{Average\ Exposure\ Concentration}{CRL_{chronic}}$$

$$HI_{chronic} = \sum_i HQ_{i\ \ chronic}$$

Some of the pollutants sampled in this study are carcinogens. The reference benchmark for cancer via an inhalation route of exposure is called an Inhalation Unit of Risk, IUR. An IUR represents an upper-bound excess lifetime cancer risk estimated to result from continuous exposure to a carcinogenic pollutant per unit of exposure concentration, and is usually expressed as a risk per μg/m^3 exposure. The following equation is used to determine the cancer risk per million population resulting from exposure to a certain concentration of a carcinogen over a lifetime (usually 70 years):

$$Cancer\ Risk\ \ per\ million\ population\ =$$
$$IUR\left(\frac{risk}{\frac{\mu g}{m^3}}\right)\times Exposure\ Concentration\left(\frac{\mu g}{m^3}\right)\times 10^6$$

Cancer risk should not be confused with an actual number of cancer cases resulting from a lifetime of exposure at a certain exposure concentration. These risks are upper bound estimates only and are used primarily for prioritizing action (e.g., cancer risks greater than 100 should have a higher action priority than cancer risks of 10).

References

1. North Carolina Administrative Code, 15A NCAC 02D.1104, http://daq.state.nc.us/rules/rules/D1104.pdf, accessed 22 August 2007.

2. http://www.epa.gov/opptintr/aegl/pubs/chemlist.htm, accessed 22 August 2007.

3. http://orise.orau.gov/emi/scapa/erpg-defn.htm and http://www.aiha.org/1documents/Committees/ERP-erpglevels.pdf, accessed 22 August 2007.

4.http://www.oehha.ca.gov/air/acute_rels/allAcRELs.html, and http://www.oehha.ca.gov/air/acute_rels/allAcRELs.html, accessed 22 August 2007.

8.3 Risk Assessment for Ammonia

8.3.1 Introduction

Ambient air was sampled continuously for ammonia at Sites A (Asheville), B (Blue Ridge), and C (Canton) using a Honeywell (Zellweger) MDA Single Point Monitor (SPM) equipped with an ammonia-specific chemically treated tape. Ammonia data were downloaded to a datalogger at 20-second intervals at Sites A and B and at 60-second intervals at Site C. The interval was dependent on datalogger specifications. The lower detection limit (LDL) for this method was 2.6 ppm (1820 $\mu g/m^3$).

The DQO for data completeness is a minimum of 75% valid data. Because of intermittent problems with datalogging and with power interruptions, this objective was not met. However, for the valid data collected, no measured concentration exceeded the LDL.

8.3.2 Acute Exposure

Since no measured concentration exceeded the LDL, no measured concentration exceeded 1820 $\mu g/m^3$. The NC AAL for ammonia for acute exposure is 2700 $\mu g/m^3$, so it can be concluded that there were no acute exposures over the periods during which valid data were collected.

8.3.3 Chronic Exposure

There is no NC AAL for chronic exposure to ammonia. However, there is an EPA IRIS RfC (Reference Concentration), which is an estimated airborne concentration to which humans (including sensitive subgroups) can be exposed up to a lifetime without resulting in an unacceptably increased risk of adverse health effects. The RfC for ammonia is 100 $\mu g/m^3$. It cannot be concluded from from this study that there is no chronic risk of exposure to ammonia.

8.3.4 Cancer Risk

Ammonia is not a carcinogen; therefore there is no risk of cancer resulting from exposure.

8.4 Risk Assessment for Airborne Carbonyl Compounds

Airborne carbonyl compounds were sampled at Sites A, B, and C in accordance with EPA Compendium Method TO-11A[1]. These carbonyl compounds are listed in Table 8.2.

Table 8.2 Carbonyls Sampled

2,4-Dimethylbenzaldehyde	Formaldehyde
Acetaldehyde	Hexanaldehyde
Acetone	Isovaleraldehyde
Acrolein	m/p-Tolualdehyde
Benzaldehyde	o-Tolualdehyde
Butyraldehyde	Propionaldehyde
Crotonaldehyde	Valeraldehyde

Only valid carbonyl data were used in data analysis. Analysis of acrolein data was not performed because EPA has invalidated the analytical method for acrolein. For statistical purposes, measured airborne concentrations less than the lower detection limit (LDL) were treated as equal to (½ x LDL). These data are shown in summary in Table 8.3 – 8.5.

Table 8.3 Airborne Concentrations (µg/m^3) for Carbonyls Sampled – Site A

Sample Log No.	Sample Date	Formaldehyde	Acetaldehyde	Acetone	Propionaldehyde	Butyraldehyde	Benzaldehyde	Crotonaldehyde	2,4-Dimethylbenz-aldehyde	Isovaleraldehyde	Valeraldehyde	o-Tolualdehyde	m/p-Tolualdehyde	Hexanaldehyde
C050306A	05/03/06	1.50	0.09	3.39	0.12	0.15	1.49	0.15	0.27	0.18	0.18	0.25	0.25	1.24
C050406A	05/04/06		0.43	0.12	0.12	0.71	3.52	0.15	0.27	0.18	0.09	0.25	0.25	0.21
C050506A	05/05/06		0.09	0.12	0.12	0.54	3.55	0.15	0.27	0.18	1.38	0.25	0.25	5.33
C050606A	05/06/06		4.40	0.95	0.76	0.83	1.14	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C050706A	05/07/06	4.08	1.08	1.73	0.12	0.54	0.22	0.15	0.27	0.18	0.66	0.25	0.25	1.64
C050806A	05/08/06	4.61	1.86	1.43	0.56	0.57	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C050906A	05/09/06	6.18	1.99	1.41	0.57	0.53	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051006A	05/10/06	6.07	1.56	0.99	0.44	0.49	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051106A	05/11/06	5.71	1.62	1.39	0.57	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051206A	05/12/06	5.12	1.83	2.05	0.59	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051306A	05/13/06	5.29	1.80	1.34	0.34	0.57	0.70	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051406A	05/14/06	4.80	1.39	1.45	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.80
C051506A	05/15/06	5.09	1.45	2.33	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051606A	05/16/06	6.41	1.83	2.70	0.36	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051706A	05/17/06	5.93	1.75	1.46	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051806A	05/18/06	5.16	1.80	1.60	0.61	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051906A	05/19/06	5.95	1.86	1.16	0.58	0.63	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C052006A	05/20/06	6.20	2.08	1.11	0.60	0.84	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C052106A	05/21/06	6.10	1.91	1.29	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C052206A	05/22/06	2.24	1.00	0.73	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.93
C052306A	05/23/06	9.47	3.30	3.10	0.91	0.71	0.85	0.15	0.27	0.18	0.18	0.25	0.25	0.21
no. of sampling days		21	21	21	21	21	21	21	21	21	21	21	21	21
% valid samples		86%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
mean conc.		5.33	1.67	1.52	0.38	0.40	0.69	0.15	0.27	0.18	0.25	0.25	0.25	0.63
st. dev.		1.69	0.95	0.84	0.26	0.26	1.01	0.00	0.00	0.00	0.28	0.00	0.00	1.15
min. conc.		1.50	0.09	0.12	0.12	0.15	0.22	0.15	0.27	0.18	0.09	0.25	0.25	0.21
max. conc.		9.47	4.40	3.39	0.91	0.84	3.55	0.15	0.27	0.18	1.38	0.25	0.25	5.33
LDL		0.12	0.18	0.24	0.24	0.29	0.43	0.30	0.55	0.35	0.35	0.49	0.49	0.41
eq 1-hr conc		127.91	40.16	36.43	9.11	9.64	16.55	3.60	6.48	4.20	6.03	5.88	5.88	15.11

Table 8.4 Airborne Concentrations ($\mu g/m^3$) for Carbonyls Sampled – Site B

Sample Log No.	Sample Date	Form-aldehyde	Acet-aldehyde	Acetone	Propion-aldehyde	Butyr-aldehyde	Benz-aldehyde	Croton-aldehyde	2,4-Dimethyl-benz-aldehyde	Isovaler-aldehyde	Valer-aldehyde	o-Tolu-aldehyde	m/p-Tolu-aldehyde	Hexan-aldehyde
C050306B	05/03/06	29.29	3.58	1.09	0.79	1.06	1.36	0.15	0.27	0.70	0.94	0.25	0.25	3.50
C050406B	05/04/06	50.47	6.92	0.58	0.88	0.99	1.42	0.15	0.27	0.18	1.39	0.25	0.25	5.60
C050506B	05/05/06	33.43	5.97	0.77	0.77	0.70	1.41	0.15	0.27	0.18	1.54	0.25	0.25	3.74
C050606B	05/06/06	38.57	8.50	1.78	0.77	1.08	1.54	0.15	0.27	0.18	0.18	0.25	0.25	0.77
C050706B	05/07/06	21.58	3.86	1.44	0.06	0.15	1.39	0.15	0.27	0.79	1.51	0.25	0.25	3.09
C050806B	05/08/06	31.78	5.05	1.90	0.57	0.65	1.18	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C050906B	05/09/06	38.22	6.05	0.12	0.12	0.15	0.29	0.15	0.27	0.18	0.97	0.25	0.25	2.02
C051006B	05/10/06	48.09	4.20	0.56	0.66	1.17	2.14	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051106B	05/11/06	19.17	4.26	2.13	0.63	0.58	0.89	0.15	0.27	1.12	1.85	0.25	1.14	4.03
C051206B	05/12/06	20.65	4.62	1.82	0.63	0.81	1.00	0.15	0.27	0.92	0.18	0.25	0.25	1.87
C051306B	05/13/06	25.02	5.67	1.11	0.75	1.00	1.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051406B	05/14/06	15.44	3.79	1.72	0.57	0.65	0.86	0.15	0.27	0.77	0.64	0.25	0.25	2.62
C051506B	05/15/06	19.68	4.32	2.39	0.66	0.77	0.97	0.15	0.27	0.18	0.18	0.25	0.25	0.81
C051606B	05/16/06	26.64	5.75	1.41	0.76	0.99	1.27	0.15	0.27	0.63	0.18	0.25	0.25	1.92
C051706B	05/17/06	20.80	4.10	1.44	0.65	0.72	1.14	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051806B	05/18/06	17.81	3.84	2.07	0.66	0.69	1.01	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051906B	05/19/06	23.07	5.07	1.50	0.77	0.90	1.22	0.15	0.27	0.60	0.18	0.25	0.25	1.88
C052006B	05/20/06	44.85	0.54	0.12	0.12	0.83	2.42	0.15	0.27	0.84	1.22	0.25	0.25	2.56
C052106B	05/21/06	0.06	0.09	0.12	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.95
C052206B	05/22/06	0.89	0.09	0.12	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C052306B	05/23/06	38.11	2.49	0.12	0.85	1.32	1.70	0.15	0.27	0.18	0.18	0.25	0.25	1.11
no. of sampling days		21	21	21	21	21	21	21	21	21	21	21	21	21
% valid samples		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
mean conc.		26.84	4.23	1.16	0.57	0.74	1.18	0.15	0.27	0.41	0.59	0.25	0.29	1.79
st. dev.		13.48	2.12	0.76	0.28	0.35	0.55	0.00	0.00	0.33	0.59	0.00	0.19	1.54
min. conc.		0.06	0.09	0.12	0.06	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
max. conc.		50.47	8.50	2.39	0.88	1.32	2.42	0.15	0.27	1.12	1.85	0.25	1.14	5.60
LDL		0.12	0.18	0.24	0.24	0.30	0.44	0.30	0.55	0.36	0.36	0.50	0.50	0.41
eq 1-hr conc		644.15	101.46	27.79	13.63	17.69	28.41	3.60	6.48	9.89	14.10	5.88	6.90	43.06

Table 8.5 Airborne Concentrations (μg/m^3) for Carbonyls Sampled – Site C

Sample Log No.	Sample Date	Form-aldehyde	Acet-aldehyde	Acetone	Propion-aldehyde	Butyr-aldehyde	Benz-aldehyde	Croton-aldehyde	2,4-Dimethyl-benz-aldehyde	Isovaler-aldehyde	Valer-aldehyde	o-Tolu-aldehyde	m/p-Tolu-aldehyde	Hexan-aldehyde
C050306C	05/03/06	3.15	2.90	5.35	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C050406C	05/04/06	11.93	2.21	1.03	0.12	0.90	0.75	0.15	0.27	0.47	0.72	0.25	0.25	2.66
C050506C	05/05/06	3.71	1.26	1.72	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C050606C	05/06/06	0.95	0.69	1.31	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C050706C	05/07/06	6.63	2.06	1.00	0.57	0.71	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C050806C	05/08/06	1.95	0.68	1.70	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C050906C	05/09/06	2.10	0.75	1.12	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051006C	05/10/06	3.02	1.13	1.16	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	2.15
C051106C	05/11/06	3.03	1.19	1.91	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051206C	05/12/06	2.76	1.10	2.00	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051306C	05/13/06	2.87	1.12	1.25	0.12	0.15	0.22	0.15	0.27	0.63	0.18	0.25	0.25	1.77
C051406C	05/14/06	2.57	1.19	1.62	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051506C	05/15/06	2.62	1.23	1.77	0.12	0.15	0.22	0.15	0.27	1.04	0.18	0.25	0.25	2.72
C051606C	05/16/06	2.33	1.28	1.54	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C051706C	05/17/06	2.74	1.16	1.26	0.12	0.15	0.22	0.15	0.27	0.64	0.18	0.25	0.25	1.95
C051806C	05/18/06	3.48	1.23	2.09	0.12	0.15	0.22	0.15	0.27	1.37	1.79	0.25	1.23	4.47
C051906C	05/19/06	3.25	1.28	1.19	0.12	0.63	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C052006C	05/20/06	4.87	1.72	1.46	0.12	0.90	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C052106C	05/21/06	1.28	0.18	0.12	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C052206C	05/22/06	3.86	1.82	1.83	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
C052306C	05/23/06	5.02	2.53	2.60	0.73	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
no. of sampling days		21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
% valid samples		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
mean conc.		3.53	1.37	1.67	0.17	0.27	0.24	0.15	0.27	0.33	0.28	0.25	0.29	0.89
st. dev.		2.30	0.64	0.98	0.16	0.26	0.12	0.00	0.00	0.33	0.37	0.00	0.21	1.22
min. conc.		0.95	0.18	0.12	0.12	0.15	0.22	0.15	0.27	0.18	0.18	0.25	0.25	0.21
max. conc.		11.93	2.90	5.35	0.73	0.90	0.75	0.15	0.27	1.37	1.79	0.25	1.23	4.47
LDL		0.12	0.18	0.24	0.24	0.30	0.44	0.30	0.30	0.36	0.36	0.50	0.50	0.41
eq 1-hr conc		84.7	32.8	40.0	4.1	6.4	5.8	3.6	6.5	7.9	6.7	5.9	7.0	21.5

The number of sampling days and percentage of valid data were determined for each carbonyl, as was mean concentration, standard deviation, minimum and maximum concentration, lower detection limit, and equivalent 1-hour concentrations. HQs, HIs, and Cancer Risks were determined for which CRLs and/or IURs existed in the prioritized CRL database. These data are shown in summary in Table 8.6 - 8.8

Table 8.6 HQs, HIs, and Cancer Risks for Carbonyls Sampled – Site A

		Formaldehyde	Acetaldehyde	Acetone	Propionaldehyde	Butyraldehyde	Benzaldehyde	Crotonaldehyde	2,4-Dimethylbenzaldehyde	Isovaleraldehyde	Valeraldehyde	o-Tolualdehyde	m/p-Tolualdehyde	Hexanaldehyde
CRL ($\mu g/m^3$)	**acute**	3.00	9.00	590	2.00	1.40	2.20	545	N/A	180	10	N/A	N/A	N/A
HQ	**acute**	42.6	4.5	0.06	4.6	6.9	7.5	0.01	N/A	0.02	0.6	N/A	N/A	N/A
Total HI	**acute**	67												
CRL ($\mu g/m^3$)	**chronic**	9.8	9	31000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HQ	**chronic**	0.54	0.19	4.9E-05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total HI	**chronic**	0.73												
Cancer	**IUR**	1.3E-05	2.2E-06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cancer per 10^6 population		69	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Added Cancer Cases		73												
Target Organs	**Neuro**					1								
	Resp	1	1											
	Liver			1										
	Repro													
	Kidney			1			1							
	Developm													
	Ocular													
	Immuno				1	1								

Table 8.7 HQs, HIs, and Cancer Risks for Carbonyls Sampled – Site B

		Formaldehyde	Acetaldehyde	Acetone	Propionaldehyde	Butyraldehyde	Benzaldehyde	Crotonaldehyde	2,4-Dimethylbenzaldehyde	Isovaleraldehyde	Valeraldehyde	o-Tolualdehyde	m/p-Tolualdehyde	Hexanaldehyde
CRL ($\mu g/m^3$)	**acute**	3	9	590	2	1.4	2.2	545	N/A	180	10	N/A	N/A	N/A
HQ	**acute**	214.7	11.3	4.7E-02	6.8	12.6	12.9	6.6E-03	N/A	0.1	1.4	N/A	N/A	N/A
Total HI	**acute**	260												
CRL ($\mu g/m^3$)	**chronic**	9.80	9.00	31000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HQ	**chronic**	2.7	0.5	3.7E-05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total HI	**chronic**	3												
Cancer	**IUR**	1.3E-05	2.2E-06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cancer per 10^6 population		349	0.5	3.7E-05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Added Cancer Cases		349												
Target Organs	**Neuro**					1								
	Resp	1	1											
	Liver			1										
	Repro													
	Kidney			1			1							
	Developm													
	Ocular													
	Immuno				1	1								

Table 8.8 HQs, HIs, and Cancer Risks for Carbonyls Sampled – Site C

		Formaldehyde	Acetaldehyde	Acetone	Propionaldehyde	Butyraldehyde	Benzaldehyde	Crotonaldehyde	2,4-Dimethylbenzaldehyde	Isovaleraldehyde	Valeraldehyde	o-Tolualdehyde	m/p-Tolualdehyde	Hexanaldehyde
CRL ($\mu g/m^3$)	**acute**	3	9	590	2	1	2	545	N/A	180	10	N/A	N/A	N/A
HQ	**acute**	28.2	3.6	0.1	2.0	4.6	2.6	6.6E-03	N/A	4.4E-02	0.7	N/A	N/A	N/A
Total HI	**acute**	42												
CRL ($\mu g/m^3$)	**chronic**	9.8	9	31000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HQ	**chronic**	0.36	0.15	5.4E-05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total HI	**chronic**	0.51												
Cancer	**IUR**	1.3E-05	2.2E-06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cancer per 10^6 population		46	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Added Cancer Cases		49												
Target Organs	**Neuro**					1								
	Resp	1	1											
	Liver			1										
	Repro													
	Kidney			1			1							
	Developm													
	Ocular													
	Immuno				1	1								

8.4.1 Site A

The total carbonyl acute HI is 67 and the total carbonyl chronic HI is 0.73. The data indicate a significant acute exposure hazard, but no chronic exposure hazard. Looking more closely at the acute exposure data, it is evident that formaldehyde (HQ=42.6), benzaldehyde (HQ=7.5), butyraldehyde (HQ=6.9), propionaldehyde (HQ=4.6), and acetaldehyde (HQ=4.5) are the risk drivers, accounting for 99% of the acute HI. Recall that acute HQs were derived by assuming a "worst-case scenario"; the 24-hour average concentration was compressed into an equivalent 1-hour period. If an equivalent 1-hour concentration is considered to be the same as the 24-hour average concentration, then the HQs for these risk drivers become: formaldehyde (HQ=1.8), benzaldehyde (HQ=0.3), butyraldehyde (HQ=0.3), propionaldehyde (HQ=0.2), and acetaldehyde (HQ=0.2). Under this scenario, the acute HI is 2.8, with the risk driver being formaldehyde. There are no sampling data available the analysis of which would tend to favor either of these two scenarios, but professional judgment may be used to conclude that the latter scenario is closer to reality than the former. It should also be noted that while the chronic HI is 0.73, the contribution to the chronic HI by formaldehyde is approximately 75%.

Cancer risk was elevated for two carbonyls (see Table 8.9).

Table 8.9 Cancer Risks, Carbonyls, Site A

Cancer Risk (per million Population)	**Carbonyl (Risk per million)**
1-10	Acetaldehyde (4)
10-100	Formaldehyde (69)
>100	None

8.4.2 Site B

The total carbonyl acute HI is 260 and the total carbonyl chronic HI is 3. The data indicate a significant acute exposure hazard and a significant chronic exposure hazard. Looking more closely at the acute exposure data, it is evident that formaldehyde (HQ=215), benzaldehyde (HQ=12.9), butyraldehyde (HQ=12.6), acetaldehyde (HQ=11.3), propionaldehyde (HQ=6.8), and, too to a lesser extent, valeraldehyde (HQ=1.4) are the risk drivers, accounting for virtually 100% of the acute HI. Recall that the acute HQs were derived by assuming a "worst-case scenario”; the 24-hour average concentration was compressed into an equivalent 1-hour period. If the equivalent 1-hour concentration is considered to be the same as the 24-hour average concentration, then the HQs for these risk drivers become: formaldehyde (HQ=8.9), benzaldehyde (HQ=0.5), butyraldehyde (HQ=0.5), propionaldehyde (HQ=0.3), and acetaldehyde (HQ=0.5). Under this scenario, the acute HI is 10.9, with the risk driver being formaldehyde. Again, using professional judgment one may conclude that the latter scenario is closer to reality than the former. The chronic HI is 3, with formaldehyde contributing approximately 90% and acetaldehyde contributing the remaining 10%. Formaldehyde is both an acute and a chronic exposure risk driver.

Cancer risk was elevated only for formaldehyde (see Table 8.10).

Table 8.10 Cancer Risk, Carbonyl Compounds, Site B

Cancer Risk (per million Population)	**Carbonyl (Risk per million)**
1-10	None
10-100	None
>100	Formaldehyde (349)

8.4.3 Site C

The total carbonyl acute HI is 42 and the total carbonyl chronic HI is 0.5. The data indicate there is an acute exposure hazard, but no chronic exposure hazard. Looking more closely at the acute exposure data, it is evident that formaldehyde (HQ=28), butyraldehyde (HQ=5), acetaldehyde (HQ=4), benzaldehyde (HQ=3), and propionaldehyde (HQ=2) are the risk drivers, accounting for virtually 100% of the acute HI. Recall that the acute HQs were derived by assuming a “worst-case scenario”; the 24-hour average concentration was compressed into an equivalent 1-hour period. If an equivalent 1-hour concentration is considered to be the same as the 24-hour average concentration, then the HQs for these risk drivers become: formaldehyde (HQ=1.2), benzaldehyde (HQ=0.5), butyraldehyde (HQ=0.2), propionaldehyde (HQ=0.1), and acetaldehyde (HQ=0.2). Under this scenario, the acute HI is 2.2, with the risk driver being formaldehyde. As before, using professional judgment, one may conclude that the latter scenario is closer to reality than the former. Having stated this, acute formaldehyde exposure is an issue that needs attention. The chronic HI is 0.5, indicating no chronic exposure problem.

Cancer risk was elevated for two carbonyls, formaldehyde and acetaldehyde (see Table 8.11).

Table 8.11 Cancer Risks, Carbonyl Compounds, Site C

Cancer Risk (per million Population)	**Carbonyl (Risk per million)**
1-10	Acetaldehyde (3)
10-100	Formaldehyde (46)
>100	None

References

1. Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC), in Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air – Second Edition, EPA/625/R-96/010b, January 1999, pp. 15-1 – 15-62.

8.5 Risk Assessment of Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOCs) were sampled at Sites A, B, and C in accordance with EPA Compendium Method TO-15 [1]. These VOCs are listed in Table 8.12.

Table 8.12 List of VOCs Sampled

1, 3-Butadiene	Benzene	Ethyl acetate	o-Xylene
1,1,1-Trichloroethane	Benzyl chloride	Ethylbenzene	p-Dichlorobenzene
1,1,2,2-Tetrachloroethane	Bromomethane	Freon-11	Styrene
1,1,2-Trichloroethane	Bromoform	Freon-113	Tetrachloroethylene
1,1-Dichloroethane	Carbon disulfide	Freon-114	Tetrahydrofuran
1,1-Dichloroethene	Carbon tetrachloride	Freon-12	Toluene
1,2,4-Trichlorobenzene	Chlorobenzene	Hexachloro-1,3-butadiene	trans-1,2-Dichloroethene
1,2,4-Trimethylbenzene	Chloroethane	m-,p-Xylene	trans-1,3-Dichloropropene
1,2-Dibromoethane	Chloroform	m-Dichlorobenzene	Trichloroethylene
1,2-Dichloroethane	Chloromethane	Methyl ethyl ketone	Vinyl acetate
1,2-Dichloropropane	cis-1,2-Dichloroethene	Methyl isobutyl ketone	Vinyl chloride
1,3,5-Trimethylbenzene	cis-1,3-Dichloropropene	Methyl n-butyl ketone	
1,4-Dioxane	Cyclohexane	Methyl tert-butyl ether	
1-Ethyl-4-methylbenzene	Dibromochloromethane	n-Heptane	
2-Propanol	Dichloromethane	n-Hexane	
Acetone	Ethanol	o-Dichlorobenzene	

Only valid VOC data were used in data analysis. Several VOCs were excluded because of variability or instrumental instability problems during analysis, or because of an insufficient percentage of valid samples collected. The excluded VOCs are: 1,2,4-trimethylbenzene; 1,2,4-trichlorobenzene; 1,4-dioxane; acetone; benzyl chloride; chloroethane; cis-1,2-dichloroethene; ethyl acetate; o-, m-, and p-dichlorobenzene; methyl ethyl ketone; methyl n-butyl ketone; styrene; tetrahydrofuran; and vinyl acetate.

The airborne concentrations for VOCs are shown in Tables 8.13 – 8.15. The number of sampling days and percentage of valid data were determined for each VOC, as was mean concentration, standard deviation, minimum and maximum concentration, lower detection limit, and equivalent 1-hour concentrations. HQs, HIs, and Cancer Risks were determined for VOCs for which CRLs and/or IURs existed in the prioritized CRL database. These data are shown in Tables 8.16 – 8.18
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Table 8.13 Airborne Concentrations (µg/m^3) for VOCs Sampled – Site A

Sample Log No.	Sample Date	Freon 12	Methyl chloride	Freon 114	Vinyl chloride	1,3-Butadiene	Bromomethane	Ethanol	Freon 11	Isopropyl Alcohol	1,1-Dichloroethene	Methylene chloride	Freon 113	Carbon Disulfide	trans-1,2 Dichloroethene	1,1-Dichloroethane	MTBE	Hexane	Chloroform	1,2-Dichloroethane	1,1,1-Trichloroethane	Benzene
V050306A	05/03/06	3.13		0.70	0.26	0.22		7.49		0.25	0.40	0.35	0.77	0.31	0.40	0.40					0.55	1.06
V050406A	05/04/06	3.29		0.70	0.26	0.22		0.19		0.25	0.40	0.35	0.77	0.31	0.40	0.40					0.55	1.26
V050606A	05/06/06	3.09		0.70	0.26	0.22		0.19		0.25	0.40	0.35	0.77	0.31	0.40	0.40					0.55	0.79
V050706A	05/07/06	3.17	1.16	0.70	0.26	0.22	0.39		1.88		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49		0.55	0.94
V050806A	05/08/06	3.32	1.28	0.70	0.26	0.22	0.39		1.88		0.40	0.35	0.77	0.64	0.40	0.40		0.35	0.49	0.40	0.55	1.16
V050906A	05/09/06	3.32	0.21	0.70	0.26	0.22	0.39		1.90		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.05
V051006A	05/10/06	3.29	1.48	0.70	0.26	0.22	0.39		1.90		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.99
V051106A	05/11/06	3.41	1.33	0.70	0.26	0.22	0.39		1.92		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.04
V051206A	05/12/06	3.08	0.21	0.70	0.26	0.22	0.39		1.88		0.40	0.35	0.77	0.31	0.40	0.40		0.80	0.49	0.40	0.55	1.37
V051306A	05/13/06	3.22	1.73	0.70	0.26	0.22	0.39		4.87		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.80
V051406A	05/14/06	3.12		0.70	0.26	0.22	0.39	3.60	1.51		0.40	0.35	0.77	0.78	0.40	0.40		0.35	0.49	0.40	0.55	0.65
V051506A	05/15/06	2.92		0.70	0.26	0.22	0.39	0.19	1.39		0.40	2.31	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.96
V051606A	05/16/06	3.15		0.70	0.26	0.22	0.39	0.19	1.51		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.79
V051706A	05/17/06	3.08		0.70	0.26	0.22	0.39	0.19	1.48		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.85
V051806A	05/18/06	3.26	1.14	0.70	0.26	0.22	0.39		1.81		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.17
V051906A	05/19/06	3.18	0.21	0.70	0.26	0.22	0.39		1.96		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.07
V052006A	05/20/06	3.25	0.21	0.70	0.26	0.22	0.39		2.39		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.19
V052106A	05/21/06	3.18	0.21	0.70	0.26	0.22	0.39		1.81		0.40	0.35	0.77	0.72	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.03
V052206A	05/22/06	3.13	0.21	0.70	0.26	0.22	0.39		1.81		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.25
V052306A	05/23/06	3.21	0.21	0.70	0.26	0.22	0.39		6.77		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.99	0.49	0.40	0.55	1.35
no. of sampling days		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
% valid samples		100%	65%	100%	100%	100%	85%	35%	85%	15%	100%	100%	100%	100%	100%	100%	30%	85%	85%	80%	100%	100%
mean conc.		3.19	0.74	0.70	0.26	0.22	0.39	1.72	2.27	0.25	0.40	0.45	0.77	0.37	0.40	0.40	0.36	0.42	0.49	0.40	0.55	1.04
st. dev.		0.11	0.61	0.00	0.00	0.00	0.00	2.84	1.39	0.00	0.00	0.44	0.00	0.15	0.00		0.00	0.18	0.00	0.00	0.00	0.20
min. conc		2.92	0.21	0.70	0.26	0.22	0.39	0.19	1.39	0.25	0.40	0.35	0.77	0.31	0.40		0.36	0.35	0.49	0.40	0.55	0.65
max. conc.		3.41	1.73	0.70	0.26	0.22	0.39	7.49	6.77	0.25	0.40	2.31	0.77	0.78	0.40		0.36	0.99	0.49	0.40	0.55	1.37
LDL		0.99	0.41	1.40	0.51	0.44	0.78	0.38	1.12	0.49	0.79	0.69	1.53	0.62	0.79	0.81	0.72	0.70	0.98	0.81	1.09	0.64
eq 1-hr conc		76.56	27.2	16.78	6.13	5.31	10.96	117.87	64.20	39.32	9.52	10.70	18.39	8.91	9.52	9.71	28.84	11.74	13.79	12.14	13.09	24.92

Table 8.13 Airborne Concentrations (µg/m^3) for VOCs Sampled – Site A cont.

Sample Log No.	Sample Date	Carbon tetrachloride	Cyclohexane	1,2 Dichloropropane	Trichloroethylene	Heptane	cis-1,3 Dichloropropene	Methyl Isobutyl Ketone	trans-1,3 Dichloropropene	1,1,2-Trichloroethane	Toluene	Dibromochloro-methane	1,2-Dibromoethane	Tetrachloro-ethylene	Chlorobenzene	Ethylbenzene	m- & p-Xylene	Bromoform	o-Xylene	1,1,2,2-Tetrachloroethane	1-ethyl-4-methyl Benzene	1,3,5-Trimethyl-benzene	Hexachloro-butadiene
V050306A	05/03/06	0.63	0.34		0.54	0.87				0.55	4.67	0.85		0.68	0.46	1.15	3.18	1.03	1.06	0.69	1.13	0.49	
V050406A	05/04/06	0.63	0.34		0.54	0.92				0.55	6.97	0.85		0.68	0.46	1.66	3.97	1.03	0.43	0.69	1.11	0.49	
V050606A	05/06/06	0.63	0.34		0.54	0.41				0.55	2.58	0.85		0.68	0.46	0.43	1.53	1.03	0.43	0.69	0.49	0.49	
V050706A	05/07/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.91	0.85	0.77	0.68	0.46	0.43	0.92	1.03	0.43		0.49	0.49	
V050806A	05/08/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	3.08	0.85	0.77	0.68	0.46	0.43	1.13	1.03	0.43		0.49	0.49	
V050906A	05/09/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	2.36	0.85	0.77	0.68	0.46	0.43	1.03	1.03	0.43		0.49	0.49	
V051006A	05/10/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	2.36	0.85	0.77	0.68	0.46	0.43	0.99	1.03	0.43		0.49	0.49	
V051106A	05/11/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	2.19	0.85	0.77	0.68	0.46	0.43	1.36	1.03	0.43		0.49	0.49	
V051206A	05/12/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	2.55	0.85	0.77	0.68	0.46	0.43	1.33	1.03	0.43		0.49	0.49	
V051306A	05/13/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	2.43	0.85	0.77	0.68	0.46	0.43	1.68	1.03	0.43		0.49	0.49	
V051406A	05/14/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	1.67	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
V051506A	05/15/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	1.45	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
V051606A	05/16/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	1.63	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
V051706A	05/17/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	2.57	0.85	0.77	0.68	0.46	0.43	1.31	1.03	0.43	0.69	0.49	0.49	1.07
V051806A	05/18/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	3.27	0.85	0.77	0.68	0.46	0.43	1.76	1.03	0.43	0.69		0.49	1.07
V051906A	05/19/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	2.42	0.85	0.77	0.68	0.46	0.43	1.29	1.03	0.43	0.69		0.49	1.07
V052006A	05/20/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	3.10	0.85	0.77	0.68	0.46	0.43	1.59	1.03	0.43	0.69		0.49	1.07
V052106A	05/21/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	2.24	0.85	0.77	0.68	0.46	0.43	1.12	1.03	0.43	0.69		0.49	1.07
V052206A	05/22/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	3.15	0.85	0.77	0.68	0.46	0.43	1.78	1.03	0.43	0.69		0.49	1.07
V052306A	05/23/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	4.76	0.85	0.77	0.68	0.46	0.43	3.02	1.03	0.99	0.69		0.49	1.07
no. of sampling days		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
% valid samples		100%	100%	85%	100%	100%	85%	35%	55%	100%	100%	100%	85%	100%	100%	100%	100%	100%	100%	65%	70%	100%	50%
mean conc.		0.63	0.34	0.46	0.54	0.46	0.45	0.41	0.45	0.55	2.87	0.85	0.77	0.68	0.46	0.53	1.52	1.03	0.49	0.69	0.58	0.49	1.07
st. dev.		0.00	0.00	0.00	0.00	0.15	0.15	0.15	0.00	0.00	1.30	0.00	0.00	0.00	0.00	0.31	0.92	0.00	0.18	0.00	0.23	0.00	0.00
min. conc		0.63	0.34	0.46	0.54	0.41	0.41	0.41	0.45	0.55	1.45	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
max. conc.		0.63	0.34	0.46	0.54	0.92	0.92	0.92	0.45	0.55	6.97	0.85	0.77	0.68	0.46	1.66	3.97	1.03	1.06	0.69	1.13	0.49	1.07
LDL		1.25	0.69	0.92	1.07	0.82	0.91	0.82	0.91	1.09	0.75	1.70	1.54	1.36	0.92	0.87	0.87	2.07	0.87	1.37	0.98	0.98	2.13
eq 1-hr conc		15.04	8.26	13.05	12.90	11.00	12.82	28.09	19.81	13.09	68.83	20.44	21.70	16.28	11.05	12.75	36.37	24.81	11.83	25.35	19.92	11.80	51.19

Table 8.14 Airborne Concentrations (μg/m^3) for VOCs Sampled – Site B

Sample Log No.	Sample Date	Freon 12	Methyl chloride	Freon 114	Vinyl chloride	1,3-Butadiene	Bromomethane	Ethanol	Freon 11	Isopropyl Alcohol	1,1-Dichloroethene	Methylene chloride	Freon 113	Carbon Disulfide	trans-1,2 Dichloroethene	1,1-Dichloroethane	MTBE	Hexane	Chloroform	1,2-Dichloroethane	1,1,1-Trichloroethane	Benzene
V050306B	05/03/06	3.05		0.70	0.26	0.22		0.19		0.25	0.40	0.35	0.77	0.31	0.40	0.40					0.55	0.98
V050506B	05/05/06	3.18		0.70	0.26	0.22		0.19		0.25	0.40	0.35	0.77	0.31	0.40	0.40					0.55	0.87
V050706B	05/07/06	3.19	1.39	0.70	0.26	0.22	0.39		1.78		0.40	0.35	0.77	1.26	0.40	0.40		0.35	0.49		0.55	1.08
V051006B	05/10/06	3.26	1.40	0.70	0.26	0.22	0.39		1.90		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.15
V051106B	05/11/06	3.12	0.21	0.70	0.26	0.22	0.39		3.23		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.00
V051206B	05/12/06	3.73	0.21	0.70	0.26	0.22	0.39		10.19		0.40	0.71	0.77	0.67	0.40	0.40		0.85	0.49	0.40	0.55	1.26
V051306B	05/13/06	3.26	2.03	0.70	0.26	0.22	0.39		1.60		0.40	0.35	0.77	0.31	0.40	0.40		0.35	1.44	0.40	0.55	0.87
V051406B	05/14/06	3.38		0.70	0.26	0.22	0.39	0.19	6.47		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.78
V051506B	05/15/06	3.22		0.70	0.26	0.22	0.39	0.19	1.57		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.86
V051606B	05/16/06	3.10		0.70	0.26	0.22	0.39	0.19	1.55		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.01
V051706B	05/17/06	3.06		0.70	0.26	0.22	0.39	0.19	1.48		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.11
V051806B	05/18/06	3.08	0.85	0.70	0.26	0.22	0.39		1.71		0.40	0.35	0.77	0.69	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.28
V051906B	05/19/06	3.17	0.21	0.70	0.26	0.22	0.39		1.77		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.10
V052006B	05/20/06	3.24	1.40	0.70	0.26	0.22	0.39		44.73		0.40	0.35	0.77	0.73	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.18
V052106B	05/21/06	3.13	0.21	0.70	0.26	0.22	0.39		1.79		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.09
V052206B	05/22/06	3.18	0.21	0.70	0.26	0.22	0.39		1.80		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.32
V052306B	05/23/06	3.08	0.21	0.70	0.26	0.22	0.39		6.82		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.26
no. of sampling days		17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
% valid samples		100%	65%	100%	100%	100%	88%	35%	88%	12%	100%	100%	100%	100%	100%	100%	35%	88%	88%	82%	100%	100%
mean conc.		3.20	0.76	0.70	0.26	0.22	0.39	0.19	5.89	0.25	0.40	0.37	0.77	0.43	0.40	0.40	0.36	0.39	0.55	0.40	0.55	1.07
st. dev.		0.161	0.685	0.000	0.000	0.000	0.000	0.000	11.056	0.000	0.000	0.088	0.000	0.259	0.000	0.000	0.000	0.127	0.246	0.000	0.000	0.163
min. conc		3.05	0.21	0.70	0.26	0.22	0.39	0.19	1.48	0.25	0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	0.78
max. conc.		3.73	2.03	0.70	0.26	0.22	0.39	0.19	44.73	0.25	0.40	0.71	0.77	1.26	0.40	0.40	0.36	0.85	1.44	0.40	0.55	1.32
LDL		0.99	0.41	1.40	0.51	0.44	0.78	0.38	1.12	0.49	0.79	0.69	1.53	0.62	0.79	0.81	0.72	0.70	0.98	0.81	1.09	0.64
eq 1-hr conc		76.9	28.0	16.8	6.1	5.3	10.6	12.8	160.2	50.1	9.5	8.9	18.4	10.4	9.5	9.7	24.5	10.5	15.0	11.8	13.1	25.7

Table 8.14 Airborne Concentrations (µg/m^3) for VOCs Sampled – Site B cont.

Sample Log No.	Sample Date	Carbon tetrachloride	Cyclohexane	1,2 Dichloropropane	Trichloroethylene	Heptane	cis-1,3 Dichloropropene	Methyl Isobutyl Ketone	trans-1,3 Dichloropropene	1,1,2-Trichloroethane	Toluene	Dibromochloromethane	1,2-Dibromoethane	Tetrachloroethylene	Chlorobenzene	Ethylbenzene	m- & p-Xylene	Bromoform	o-Xylene	1,1,2,2-Tetrachloroethane	1-ethyl-4-methyl Benzene	1,3,5-Trimethyl-benzene	Hexachlorobutadiene
V050306B	05/03/06	0.63	0.34		0.54	0.41				0.55	2.52	0.85		0.68	0.46	0.43	1.91	1.03	0.43	0.69	0.49	0.49	
V050506B	05/05/06	0.63	0.34		0.54	0.41				0.55	1.98	0.85		0.68	0.46	0.43	1.29	1.03	0.43	0.69	0.49	0.49	
V050706B	05/07/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.65	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43		0.49	0.49	
V051006B	05/10/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.76	0.85	0.77	0.68	0.46	0.43	0.94	1.03	0.43		0.49	0.49	
V051106B	05/11/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.22	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43		0.49	0.49	
V051206B	05/12/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	2.04	0.85	0.77	0.68	0.46	0.43	1.36	1.03	0.43		0.49	0.49	
V051306B	05/13/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.23	0.85	0.77	0.68	0.46	0.43	0.89	1.03	0.43		0.49	0.49	
V051406B	05/14/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	1.10	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
V051506B	05/15/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	1.30	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
V051606B	05/16/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	1.96	0.85	0.77	0.68	0.46	0.43	0.99	1.03	0.43	0.69	0.49	0.49	1.07
V051706B	05/17/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	2.51	0.85	0.77	0.68	0.46	0.43	1.22	1.03	0.43	0.69	0.49	0.49	1.07
V051806B	05/18/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	2.03	0.85	0.77	0.68	0.46	0.43	1.39	1.03	0.43	0.69		0.49	1.07
V051906B	05/19/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	1.35	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69		0.49	1.07
V052006B	05/20/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	1.71	0.85	0.77	0.68	0.46	0.43	0.91	1.03	0.43	0.69		0.49	1.07
V052106B	05/21/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	1.58	0.85	0.77	0.68	0.46	0.43	1.27	1.03	0.43	0.69		0.49	1.07
V052206B	05/22/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	2.36	0.85	0.77	0.68	0.46	0.43	1.40	1.03	0.43	0.69		0.49	1.07
V052306B	05/23/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	2.01	0.85	0.77	0.68	0.46	0.43	1.12	1.03	0.43	0.69		0.49	1.07
no. of sampling days		17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
% valid samples		100%	100%	88%	100%	100%	88%	29%	53%	100%	100%	100%	88%	100%	100%	100%	100%	100%	100%	71%	65%	100%	59%
mean conc.		0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.78	0.85	0.77	0.68	0.46	0.43	0.99	1.03	0.43	0.69	0.49	0.49	1.07
st. dev.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.449	0.000	0.000	0.000	0.000	0.000	0.441	0.000	0.000	0.000	0.000	0.000	0.000
min. conc		0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.10	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
max. conc.		0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	2.52	0.85	0.77	0.68	0.46	0.43	1.91	1.03	0.43	0.69	0.49	0.49	1.07
LDL		1.25	0.69	0.92	1.07	0.82	0.91	0.82	0.91	1.09	0.75	1.70	1.54	1.36	0.92	0.87	0.87	2.07	0.87	1.37	0.98	0.98	2.13
eq 1-hr conc		15.0	8.3	12.6	12.9	9.8	12.3	33.4	20.6	13.1	42.8	20.4	20.9	16.3	11.0	10.4	23.8	24.8	10.4	23.3	18.2	11.8	43.5

Table 8.15 Airborne Concentrations (μg/m^3) for VOCs Sampled – Site C

Sample Log No.	Sample Date	Freon 12	Methyl chloride	Freon 114	Vinyl chloride	1,3-Butadiene	Bromomethane	Ethanol	Freon 11	Isopropyl Alcohol	1,1-Dichloroethene	Methylene chloride	Freon 113	Carbon Disulfide	trans-1,2 Dichloroethene	1,1-Dichloroethane	MTBE	Hexane	Chloroform	1,2-Dichloroethane	1,1,1-Trichloroethane	Benzene
V050306C	05/03/06	2.86		0.70	0.26	0.22		0.85		0.25	0.40	0.35	0.77	0.31	0.40	0.40					0.55	1.23
V050406C	05/04/06	3.03		0.70	0.26	0.22		0.19		0.25	0.40	0.35	0.77	0.31	0.40	0.40					0.55	1.13
V050506C	05/05/06	3.01		0.70	0.26	0.22		0.19		0.25	0.40	0.35	0.77	0.31	0.40	0.40					0.55	0.94
V050606C	05/06/06	3.34	1.53	0.70	0.26	0.22	0.39		1.98		0.40	0.35	0.77	0.31	0.40	0.40		0.73	0.49		0.55	1.40
V050706C	05/07/06	2.44	0.90	0.70	0.26	0.22	0.39		1.65		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49		0.55	0.87
V050806C	05/08/06	2.75	0.21	0.70	0.26	0.22	0.39		1.62		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.10
V050906C	05/09/06	3.15	1.26	0.70	0.26	0.22	0.39		1.81		0.40	0.35	0.77	0.63	0.40	0.40		0.35	0.49	0.40	0.55	1.17
V051006C	05/10/06	3.20	1.45	0.70	0.26	0.22	0.39		1.93		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.27
V051106C	05/11/06	3.09	0.21	0.70	0.26	0.22	0.39		1.81		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.98
V051206C	05/12/06	3.04	0.21	0.70	0.26	0.22	0.39		1.58		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.20
V051306C	05/13/06	3.23	2.01	0.70	0.26	0.22	0.39		1.59		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.96
V051406C	05/14/06	2.87		0.70	0.26	0.22	0.39	2.49	1.51		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.72
V051506C	05/15/06	2.84		0.70	0.26	0.22	0.39	0.19	1.40		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.70
V051606C	05/16/06	2.88		0.70	0.26	0.22	0.39	0.19	1.46		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	0.97
V051706C	05/17/06	3.07		0.70	0.26	0.22	0.39	0.19	1.53		0.40	0.35	0.77	0.31	0.40	0.40		0.35	0.49	0.40	0.55	1.18
V051806C	05/18/06	3.11	1.10	0.70	0.26	0.22	0.39		1.69		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.20
V051906C	05/19/06	3.12	1.10	0.70	0.26	0.22	0.39		1.74		0.40	0.35	0.77	0.70	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.13
V052006C	05/20/06	2.87	0.21	0.70	0.26	0.22	0.39		1.58			0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.27
V052106C	05/21/06	3.05	0.21	0.70	0.26	0.22	0.39		1.72		0.40	0.35	0.77	0.74	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.21
V052206C	05/22/06	3.08	0.21	0.70	0.26	0.22	0.39		6.50		0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.78	0.49	0.40	0.55	2.43
V052306C	05/23/06	3.14	0.21	0.70	0.26	0.22	0.39		6.34			0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	1.27
no. of sampling days		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
% valid samples		100%	67%	100%	100%	100%	86%	33%	86%	14%	90%	100%	100%	100%	100%	100%	29%	86%	86%	76%	100%	100%
mean conc.		3.01	0.77	0.70	0.26	0.22	0.39	0.61	2.19	0.25	0.40	0.35	0.77	0.37	0.40	0.40	0.36	0.40	0.49	0.40	0.55	1.16
st. dev.		0.195	0.637	0.000	0.000	0.000	0.000	0.866	1.546	0.000	0.000	0.000	0.000	0.137	0.000	0.000	0.000	0.129	0.000	0.000	0.000	0.346
min. conc		2.44	0.21	0.70	0.26	0.22	0.39	0.19	1.40	0.25	0.40	0.35	0.77	0.31	0.40	0.40	0.36	0.35	0.49	0.40	0.55	0.70
max. conc.		3.34	2.01	0.70	0.26	0.22	0.39	2.49	6.50	0.25	0.40	0.35	0.77	0.74	0.40	0.40	0.36	0.78	0.49	0.40	0.55	2.43
LDL		0.49	0.41	1.40	0.51	0.44	0.78	0.38	1.12	0.49	0.79	0.69	1.53	0.62	0.79	0.81	0.72	0.70	0.98	0.81	1.09	0.64
eq 1-hr conc		72.2	27.8	16.8	6.1	5.3	10.9	44.1	61.4	N/A	10.5	8.3	18.4	8.8	9.5	9.7	30.3	11.1	13.7	12.7	13.1	27.8

Table 8.15 Airborne Concentrations (µg/m^3) for VOCs Sampled – Site C cont.

Sample Log No.	Sample Date	Carbon tetrachloride	Cyclohexane	1,2 Dichloropropane	Trichloroethylene	Heptane	cis-1,3 Dichloropropene	Methyl Isobutyl Ketone	trans-1,3 Dichloropropene	1,1,2-Trichloroethane	Toluene	Dibromochloromethane	1,2-Dibromoethane	Tetrachloroethylene	Chlorobenzene	Ethylbenzene	m- & p-Xylene	Bromoform	o-Xylene	1,1,2,2-Tetrachloroethane	1-ethyl-4-methyl Benzene	1,3,5-Trimethyl-benzene	Hexachlorobutadiene
V050306C	05/03/06	0.63	0.34		0.54	0.41				0.55	3.35	0.85		0.68	0.46	0.43	2.67	1.03	0.92	0.69	1.46	0.49	
V050406C	05/04/06	0.63	0.34		0.54	0.41				0.55	2.51	0.85		0.68	0.46	0.43	1.77	1.03	0.43	0.69	0.49	0.49	
V050506C	05/05/06	0.63	0.34		0.54	0.41				0.55	1.69	0.85		0.68	0.46	0.43	1.46	1.03	0.43	0.69	0.49	0.49	
V050606C	05/06/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	2.55	0.85	0.77	0.68	0.46	0.43	1.35	1.03	0.43		0.49	0.49	
V050706C	05/07/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	0.92	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43		0.49	0.49	
V050806C	05/08/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.38	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43		0.49	0.49	
V050906C	05/09/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.51	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43		0.49	0.49	
V051006C	05/10/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.84	0.85	0.77	0.68	0.46	0.43	1.17	1.03	0.43		0.49	0.49	
V051106C	05/11/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	0.96	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43		0.49	0.49	
V051206C	05/12/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.77	0.85	0.77	0.68	0.46	0.43	1.42	1.03	0.43		0.49	0.49	
V051306C	05/13/06	0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.27	0.85	0.77	0.68	0.46	0.43	1.09	1.03	0.43		0.49	0.49	
V051406C	05/14/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	0.88	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
V051506C	05/15/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	0.81	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
V051606C	05/16/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	1.54	0.85	0.77	0.68	0.46	0.43	1.16	1.03	0.43	0.69	0.49	0.49	1.07
V051706C	05/17/06	0.63	0.34	0.46	0.54	0.41	0.45		0.45	0.55	2.14	0.85	0.77	0.68	0.46	0.43	1.22	1.03	0.43	0.69	0.49	0.49	1.07
V051806C	05/18/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	1.47	0.85	0.77	0.68	0.46	0.43	0.88	1.03	0.43	0.69		0.49	1.07
V051906C	05/19/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	1.29	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69		0.49	1.07
V052006C	05/20/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	2.54	0.85	0.77	0.68	0.46	0.43	1.22	1.03	0.43	0.69		0.49	1.07
V052106C	05/21/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	1.56	0.85	0.77	0.68	0.46	0.43	0.88	1.03	0.43	0.69		0.49	1.07
V052206C	05/22/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	2.28	0.85	0.77	0.68	0.46	0.43	1.44	1.03	0.43	0.69		0.49	1.07
V052306C	05/23/06	0.63	0.34	0.46	0.54	0.41	0.45			0.55	1.94	0.85	0.77	0.68	0.46	0.43	1.32	1.03	0.43	0.69		0.49	1.07
no. of sampling days		21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
% valid samples		100%	100%	86%	100%	100%	86%	38%	57%	100%	100%	100%	86%	100%	100%	100%	100%	100%	100%	62%	71%	100%	48%
mean conc.		0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	1.72	0.85	0.77	0.68	0.46	0.43	1.05	1.03	0.46	0.69	0.56	0.49	1.07
st. dev.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.655	0.000	0.000	0.000	0.000	0.000	0.574	0.000	0.106	0.000	0.249	0.000	0.000
min. conc		0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	0.81	0.85	0.77	0.68	0.46	0.43	0.43	1.03	0.43	0.69	0.49	0.49	1.07
max. conc.		0.63	0.34	0.46	0.54	0.41	0.45	0.41	0.45	0.55	2.55	0.85	0.77	0.68	0.46	0.43	1.77	1.03	0.43	0.69	0.49	0.49	1.07
LDL		1.25	0.69	0.92	1.07	0.82	0.91	0.82	0.91	1.09	0.75	1.70	1.54	1.36	0.92	0.87	0.87	2.07	0.87	1.37	0.98	0.98	2.13
eq 1-hr conc		15.0	8.3	12.9	12.9	9.8	12.7	25.8	19.1	13.1	41.4	20.4	21.5	16.3	11.0	10.4	25.3	24.8	11.0	26.6	18.7	11.8	53.8

Table 8.16 HQs, HIs, and Cancer Risks for VOCs Sampled – Site A

		Freon 12	Methyl chloride	Freon 114	Vinyl chloride	1,3-Butadiene	Bromomethane	Ethanol	Freon 11	Isopropyl Alcohol	1,1-Dichloroethene	Methylene chloride	Freon 113	Carbon Disulfide	trans-1,2 Dichloroethene	1,1-Dichloroethane	MTBE
CRL (μg/m^3)	**acute**	N/A	1740	N/A	1280	22000	196	N/A	N/A	N/A	N/A	1700	950000	40500	810	N/A	7211
HQ	**acute**	N/A	0.02	N/A	0.00	0.00	0.06	N/A	N/A	N/A	N/A	0.01	0.00	0.00	0.01	N/A	0.00
Total HI	**acute**	0.23															
CRL (μg/m^3)	**chronic**	248000	174	N/A	77	2	19	N/A	700	220	200	210	700	186	73	510	2500
HQ	**chronic**	1.3E-05	0.004	N/A	0.003	0.111	0.020	N/A	0.003	0.001	0.002	0.002	0.001	0.002	0.005	0.001	1.4E-04
Total HI	**chronic**	0.32															
Cancer	**IUR**	N/A	N/A	N/A	8.80E-06	3.00E-05	N/A	N/A	N/A	N/A	N/A	4.70E-07	N/A	N/A	N/A	N/A	N/A
Cancer per 10^6 population		N/A	N/A	N/A	2	7	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A	N/A
Total Added Cancer Cases		121															
Target Organs	**Neuro**		1											1			
	Resp																
	Liver				1			1				1					1
	Repro					1											
	Kidney																1
	Developm																
	Ocular																1
	Immuno																

Table 8.16 HQs, HIs, and Cancer Risks for VOCs Sampled – Site A cont.

		Hexane	Chloroform	1,2-Dichloroethane	1,1,1-Trichloroethane	Benzene	Carbon tetrachloride	Cyclohexane	1,2 Dichloropropane	Trichloroethylene	Heptane	cis-1,3 Dichloropropene	Methyl Isobutyl Ketone	trans-1,3 Dichloropropene	1,1,2-Trichloroethane
CRL ($\mu g/m^3$)	acute	11600000	490	202000	245000	160000	283000	N/A	202	13730	N/A	N/A	30000	N/A	N/A
HQ	acute	0.00	0.03	0.00	0.00	0.00	0.00	N/A	0.06	0.00	N/A	N/A	0.00	N/A	N/A
Total HI	acute														
CRL ($\mu g/m^3$)	chronic	1100	97	510	12000	30	188	6000	4	690	N/A	N/A	2560	N/A	N/A
HQ	chronic	3.8E-04	0.005	0.001	4.5E-05	0.035	0.003	5.7E-05	0.116	0.001	N/A	N/A	1.6E-04	N/A	N/A
Total HI	chronic														
Cancer	IUR	N/A	2.30E-05	2.60E-05	N/A	2.20E-06	1.50E-05	N/A	N/A	2.00E-06	N/A	N/A	N/A	N/A	1.60E-05
Cancer per 10^6 population		N/A	11	11	N/A	2	9	N/A	N/A	1	N/A	N/A	N/A	N/A	9
Total Added Cancer Cases															
Target Organs	Neuro	1			1										
	Resp	1										1		1	
	Liver		1				1								1
	Repro														
	Kidney														
	Developm												1		
	Ocular									1					
	Immuno					1									

Table 8.16 HQs, HIs, and Cancer Risks for VOCs Sampled – Site A cont.

		Toluene	Dibromochloromethane	1,2-Dibromoethane	Tetrachloroethylene	Chlorobenzene	Ethylbenzene	m- & p-Xylene	Bromoform	o-Xylene	1,1,2,2-Tetrachloroethane	1-ethyl-4-methyl Benzene	1,3,5-Trimethyl-benzene	Hexachlorobutadiene
CRL (μg/m^3)	**acute**	3770	N/A	N/A	1360	N/A	N/A	65000	N/A	65000	N/A	N/A	688000	10700
HQ	**acute**	0.02	N/A	N/A	0.01	N/A	N/A	0.00	N/A	0.00	N/A	N/A	0.00	0.00
Total HI	**acute**													
CRL (μg/m^3)	**chronic**	4700	N/A	N/A	270	2200	1000	2700	N/A	2700	N/A	N/A	N/A	N/A
HQ	**chronic**	0.001	N/A	N/A	0.003	2.1E-04	0.001	0.001	N/A	1.8E-04	N/A	N/A	N/A	N/A
Total HI	**chronic**													
Cancer	**IUR**	N/A	N/A	N/A	5.90E-06	N/A	N/A	N/A	1.10E-06	N/A	5.80E-05	N/A	N/A	2.20E-05
Cancer per 10^6 population		N/A	N/A	N/A	4	N/A	N/A	N/A	1	N/A	40	N/A	N/A	23
Total Added Cancer Cases														
Target Organs	**Neuro**	1			1			1		1				
	Resp	1												
	Liver					1								
	Repro					1								1
	Kidney					1								
	Developm						1							
	Ocular													
	Immuno													

Table 8.17 HQs, HIs, and Cancer Risks for VOCs Sampled – Site B

		Freon 12	Methyl chloride	Freon 114	Vinyl chloride	1,3-Butadiene	Bromomethane	Ethanol	Freon 11	Isopropyl Alcohol	1,1-Dichloroethene	Methylene chloride	Freon 113	Carbon Disulfide	trans-1,2 Dichloroethene	1,1-Dichloroethane	MTBE
CRL (μg/m^3)	**acute**	N/A	1740	N/A	1280	22000	196	N/A	N/A	N/A	N/A	1700	950000	40500	810	N/A	7211
HQ	**acute**	N/A	0.016	N/A	0.005	2.4E-04	0.054	N/A	N/A	N/A	N/A	0.005	1.9E-05	2.6E-04	0.012	N/A	0.003
Total HI	**acute**	0.22															
CRL (μg/m^3)	**chronic**	248000	174	N/A	77	2	19	N/A	700	220	200	210	700	186	73	510	2500
HQ	**chronic**	1.3E-05	0.004	N/A	0.003	0.111	0.020	N/A	0.008	0.001	0.002	0.002	0.001	0.002	0.005	0.001	1.4E-04
Total HI	**chronic**	0.33															
Cancer	**IUR**	N/A	N/A	N/A	8.8E-06	3.0E-05	N/A	N/A	N/A	N/A	N/A	4.7E-07	N/A	N/A	N/A	N/A	N/A
Cancer per 10^6 population		N/A	N/A	N/A	2.25	6.64	N/A	N/A	N/A	N/A	N/A	0.17	N/A	N/A	N/A	N/A	N/A
Total Added Cancer Cases		122															
Target Organs	**Neuro**		1											1			
	Resp																
	Liver				1			1				1					1
	Repro					1											
	Kidney																1
	Developm																
	Ocular																1
	Immuno																

Table 8.17 HQs, HIs, and Cancer Risks for VOCs Sampled – Site B cont.

		Hexane	Chloroform	1,2-Dichloroethane	1,1,1-Trichloroethane	Benzene	Carbon tetrachloride	Cyclohexane	1,2 Dichloropropane	Trichloroethylene	Heptane	cis-1,3 Dichloropropene	Methyl Isobutyl Ketone	trans-1,3 Dichloropropene	1,1,2-Trichloroethane
CRL ($\mu g/m^3$)	**acute**	11600000	490	202000	245000	160000	283000	N/A	202	13730	N/A	N/A	30000	N/A	N/A
HQ	**acute**	9.0E-07	0.031	5.8E-05	5.3E-05	1.6E-04	5.3E-05	N/A	0.062	0.001	N/A	N/A	0.001	N/A	N/A
Total HI	**acute**														
CRL ($\mu g/m^3$)	**chronic**	1100	97	510	12000	30	188	6000	4	690	N/A	N/A	2560	N/A	N/A
HQ	**chronic**	0.0	0.006	0.001	4.5E-05	0.036	0.003	5.7E-05	0.116	0.001	N/A	N/A	1.6E-04	N/A	N/A
Total HI	**chronic**														
Cancer	**IUR**	N/A	2.3E-05	2.6E-05	N/A	2.2E-06	1.5E-05	N/A	N/A	2.0E-06	N/A	N/A	N/A	N/A	1.6E-05
Cancer per 10^6 population		N/A	12.69	10.52	N/A	2.36	9.40	N/A	N/A	1.07	N/A	N/A	N/A	N/A	8.73
Total Added Cancer Cases															
Target Organs	**Neuro**	1			1										
	Resp	1										1		1	
	Liver		1				1								1
	Repro														
	Kidney														
	Developm												1		
	Ocular									1					
	Immuno					1									

Table 8.17 HQs, HIs, and Cancer Risks for VOCs Sampled – Site B cont.

		Toluene	Dibromochloromethane	1,2-Dibromoethane	Tetrachloroethylene	Chlorobenzene	Ethylbenzene	m- & p-Xylene	Bromoform	o-Xylene	1,1,2,2-Tetrachloroethane	1-ethyl-4-methyl Benzene	1,3,5-Trimethyl-benzene	Hexachlorobutadiene
CRL (µg/m^3)	**acute**	3770	N/A	N/A	1360	N/A	N/A	65000	N/A	65000	N/A	N/A	688000	10700
HQ	**acute**	0.011	N/A	N/A	0.012	N/A	N/A	3.7E-04	N/A	1.6E-04	N/A	N/A	1.7E-05	0.004
Total HI	**acute**													
CRL (µg/m^3)	**chronic**	4700	N/A	N/A	270	2200	1000	2700	N/A	2700	N/A	N/A	N/A	N/A
HQ	**chronic**	3.8E-04	N/A	N/A	0.003	2.1E-04	4.3E-04	3.7E-04	N/A	0.000	N/A	N/A	N/A	N/A
Total HI	**chronic**													
Cancer	**IUR**	N/A	N/A	N/A	5.9E-06	N/A	N/A	N/A	1.1E-06	N/A	5.8E-05	N/A	N/A	2.2E-05
Cancer per 10^6 population		N/A	N/A	N/A	4.00	N/A	N/A	N/A	1.14	N/A	39.82	N/A	N/A	23.46
Total Added Cancer Cases														
Target Organs	**Neuro**	1			1			1		1				
	Resp	1												
	Liver					1								
	Repro					1								1
	Kidney					1								
	Developm						1							
	Ocular													
	Immuno													

Table 8.18 HQs, HIs, and Cancer Risks for VOCs Sampled – Site C

		Freon 12	Methyl chloride	Freon 114	Vinyl chloride	1,3-Butadiene	Bromomethane	Ethanol	Freon 11	Isopropyl Alcohol	1,1-Dichloroethene	Methylene chloride	Freon 113	Carbon Disulfide	trans-1,2 Dichloroethene	1,1-Dichloroethane	MTBE
CRL ($\mu g/m^3$)	**acute**	N/A	1740	N/A	1280	22000	196	N/A	N/A	N/A	N/A	1700	950000	40500	810	N/A	7211
HQ	**acute**	N/A	0.016	N/A	0.005	2.4E-04	0.055	N/A	N/A	N/A	N/A	0.005	1.9E-05	2.2E-04	0.012	N/A	0.004
Total HI	**acute**	0.22															
CRL ($\mu g/m^3$)	**chronic**	248000	174	N/A	77	2	19	N/A	700	220	200	210	700	186	73	510	2500
HQ	**chronic**	1.2E-05	0.004	N/A	0.003	0.111	0.020	N/A	0.003	N/A	0.002	0.002	0.001	0.002	0.005	0.001	1.4E-04
Total HI	**chronic**	0.32															
Cancer	**IUR**	N/A	N/A	N/A	8.8E-06	3.0E-05	N/A	N/A	N/A	N/A	N/A	4.7E-07	N/A	N/A	N/A	N/A	N/A
Cancer per 10^6 population		N/A	N/A	N/A	2	7	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A	N/A
Total Added Cancer Cases		121															
Target Organs	**Neuro**		1											1			
	Resp																
	Liver				1			1				1					1
	Repro					1											
	Kidney																1
	Developm																
	Ocular																1
	Immuno																

Table 8.18 HQs, HIs, and Cancer Risks for VOCs Sampled – Site C cont.

		Hexane	Chloroform	1,2-Dichloroethane	1,1,1-Trichloroethane	Benzene	Carbon tetrachloride	Cyclohexane	1,2 Dichloropropane	Trichloroethylene	Heptane	cis-1,3 Dichloropropene	Methyl Isobutyl Ketone	trans-1,3 Dichloropropene	1,1,2-Trichloroethane
CRL ($\mu g/m^3$)	**acute**	11600000	490	202000	245000	160000	283000	N/A	202	13730	N/A	N/A	30000	N/A	N/A
HQ	**acute**	9.6E-07	0.028	6.3E-05	5.3E-05	1.7E-04	5.3E-05	N/A	0.064	0.001	N/A	N/A	0.001	N/A	N/A
Total HI	**acute**														
CRL ($\mu g/m^3$)	**chronic**	1100	97	510	12000	30	188	6000	4	690	N/A	N/A	2560	N/A	N/A
HQ	**chronic**	3.6E-04	0.005	0.001	4.5E-05	0.039	0.003	5.7E-05	0.116	0.001	N/A	N/A	0.000	N/A	N/A
Total HI	**chronic**														
Cancer	**IUR**	N/A	2.3E-05	2.6E-05	N/A	2.2E-06	1.5E-05	N/A	N/A	2.0E-06	N/A	N/A	N/A	N/A	1.6E-05
Cancer per 10^6 population		N/A	11	11	N/A	3	9	N/A	N/A	1	N/A	N/A	N/A	N/A	9
Total Added Cancer Cases															
Target Organs	**Neuro**	1			1										
	Resp	1										1		1	
	Liver		1				1								1
	Repro														
	Kidney														
	Developm												1		
	Ocular									1					
	Immuno					1									

Table 8.18 HQs, HIs, and Cancer Risks for VOCs Sampled – Site C cont.

		Toluene	Dibromochloromethane	1,2-Dibromoethane	Tetrachloroethylene	Chlorobenzene	Ethylbenzene	m- & p-Xylene	Bromoform	o-Xylene	1,1,2,2-Tetrachloroethane	1-ethyl-4-methyl Benzene	1,3,5-Trimethyl-benzene	Hexachlorobutadiene
CRL ($\mu g/m^3$)	**acute**	3770	N/A	N/A	1360	N/A	N/A	65000	N/A	65000	N/A	N/A	688000	10700
HQ	**acute**	0.011	N/A	N/A	0.012	N/A	N/A	3.9E-04	N/A	1.7E-04	N/A	N/A	1.7E-05	0.005
Total HI	**acute**													
CRL ($\mu g/m^3$)	**chronic**	4700	N/A	N/A	270	2200	1000	2700	N/A	2700	N/A	N/A	N/A	N/A
HQ	**chronic**	0.000	N/A	N/A	0.003	2.1E-04	4.3E-04	3.9E-04	N/A	1.7E-04	N/A	N/A	N/A	N/A
Total HI	**chronic**													
Cancer	**IUR**	N/A	N/A	N/A	5.9E-06	N/A	N/A	N/A	1.1E-06	N/A	5.8E-05	N/A	N/A	2.2E-05
Cancer per 10^6 population		N/A	N/A	N/A	4	N/A	N/A	N/A	1	N/A	40	N/A	N/A	23
Total Added Cancer Cases														
Target Organs	**Neuro**	1			1			1		1				
	Resp	1												
	Liver					1								
	Repro					1								1
	Kidney					1								
	Developm						1							
	Ocular													
	Immuno													

8.5.1 Site A

Since the total VOC acute HI is 0.23 and the total VOC chronic HI is 0.32, the data indicate there is no acute or chronic exposure hazard.

Cancer risk was elevated for several VOCs (see Table 8.19) It must be noted that the airborne concentrations of all VOCs in Table 8.19, with the exception of benzene, were below the Level of Detection (LDL) for the method. The cancer risk benchmark when multiplied by (1/2 x LDL, which is still relatively elevated) value yields cancer risk in excess of 1 in a million. The risk associated with these compounds should be considered "inconclusive."

Table 8.19 Cancer Risks, VOCs, Site A

Cancer Risk (per million Population)	**VOC (Risk per million)**	
1-10	*Bromoform**	*Tetrachloroethylene*
	Trichloroethylene	*1,3-Butadiene*
	Benzene (2)	*Carbon Tetrachloride*
	Vinyl Chloride	*1,1,2-Trichloroethylene*
10-100	*Chloroform*	*Hexachlorobutadiene*
	1,2-Dichloroethane	*1,1,2,2-Tetrachloroethane*
>100	None	

**Italicized VOCs are "inconclusive"*

8.5.2 Site B

Since the total VOC acute HI is 0.22 and the total VOC chronic HI is 0.33, the data indicate there is no acute or chronic exposure hazard.

Cancer risk was elevated for several VOCs (see Table 8.20). It must be noted that the airborne concentrations of all VOCs in Table 8.20, with the exception of benzene and chloroform, were below the Level of Detection (LDL) for the method. The cancer risk benchmark when multiplied by (1/2 x LDL, which is still relatively elevated) value yields cancer risk in excess of 1 in a million.

Table 8.20 Cancer Risk, VOCs, Site B

Cancer Risk per million Population	VOC (Risk per million)	
1-10	*Bromoform**	*Tetrachloroethylene*
	Trichloroethylene	*1,3-Butadiene*
	Benzene (2)	*Carbon Tetrachloride*
	Vinyl Chloride	*1,1,2-Trichloroethylene*
10-100	Chloroform (13)	*Hexachlorobutadiene*
	1,2-Dichloroethane	*1,1,2,2-Tetrachloroethane*
>100	None	

**Italicized VOCs are "inconclusive"*

8.5.3 Site C

Since the total VOC acute HI is 0.22 and the total VOC chronic HI is 0.35, the data indicate there is no acute or chronic exposure hazard.

Cancer risk was elevated for several VOCs (see Table 8.21). It must be noted that the airborne concentrations of all VOCs in Table 8.21, with the exception of benzene, were below the Level of Detection (LDL) for the method. The cancer risk benchmark when multiplied by (1/2 x LDL, which is still relatively elevated) value yields cancer risk in excess of 1 in a million.

Table 8.21 Cancer Risks, VOCs, Site C

Cancer Risk per million Population	VOC (Risk per million)	
1-10	*Bromoform**	*Tetrachloroethylene*
	Trichloroethylene	*1,3-Butadiene*
	Vinyl Chloride	*1,1,2-Trichloroethylene*
	Benzene (3)	*Carbon Tetrachloride*
10-100	*Chloroform*	*Hexachlorobutadiene*
	1,2-Dichloroethane	*1,1,2,2-Tetrachloroethane*
>100	None	

**Italicized VOCs are "inconclusive"*

References

1. *Determination of VOCs in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography-Mass Spectroscopy (GC/MS)*, in **Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air – Second Edition**, EPA/625/R-96/010b, January 1999, pp. 15-1 – 15-62.

8.6 Risk Assessment for Mercury

Airborne mercury was monitored at Sites A and C. Monitoring occurred at Site A over the period April 30 – May 20, 2006, and at Site C over the period May 1 - 24, 2006.

At Site A (Asheville), the mean measured concentration of total gaseous mercury (TGM) was 1.3 ng/m^3. The concentration of TGM is the sum of the concentrations of elemental mercury vapor ($Hg^{(0)}$) and reactive gaseous mercury (RGM). Because historically RGM concentration is about 3 orders of magnitude less than $Hg^{(0)}$, TGM concentration is $Hg^{(0)}$. At Site C (Canton), the mean measured concentration of total gaseous mercury (TGM) was 1.6 ng/m^3.

A benchmark for acute exposure to $Hg^{(0)}$ is the 8-hr AEGL-2**,** 1.7 x 10^6 ng/m^3. The NC AAL for chronic exposure (24-hr basis) to $Hg^{(0)}$ is 0.6 $\mu g/m^3$ (600 ng/m^3). The EPA-IRIS RfC (chronic exposure) for $Hg^{(0)}$ is 0.3 $\mu g/m^3$ (300 ng/m^3). The $Hg^{(0)}$ sampled at both Sites A and C are clearly less than the acute and chronic benchmarks. Exposure to airborne $Hg^{(0)}$ does not pose a risk to health, based on these data.

8.7 Risk Assessment for RSCs

8.7.1 Introduction

Airborne reduced sulfur compounds (RSCs) were sampled at Sites A, B, and C in 6-Liter SilcoSteel® canisters fitted with restrictive orifices. Samples were collected over a 24-hour sampling period. These RSCs are listed in Table 8.22.

Table 8.22 Reduced Sulfur Compounds Sampled

Hydrogen Sulfide	Thiophene
Carbonyl Sulfide	Diethyl Sulfide
Methyl Mercaptan	n-Butyl Mercaptan
Ethyl Mercaptan	Dimethyl Disulfide
Dimethyl Sulfide	3-Methylthiophene
Carbon Disulfide	Tetrahydrothiophene
Isopropyl Mercaptan	2-Ethylthiophene
tert-Butyl Mercaptan	2,5-Dimethylthiophene
Isobutyl Mercaptan	Diethyl Disulfide

Only valid RSC data were used in data analysis. For statistical purposes, measured airborne concentrations less than the LDL were treated as equal to (½ x LDL). These data are shown in summary in Tables 8.23 – 8.25. The number of sampling days and percentage of valid data were determined for each carbonyl, as was mean concentration, standard deviation, minimum and maximum concentration, lower detection limit, and equivalent 1-hour concentrations. HQs, HIs, and Cancer Risks were determined for RSCs for which CRLs and/or IURs existed in the prioritized CRL database. These data are shown in Tables 8.26 – 8.28

Table 8.23 Airborne Concentrations ($\mu g/m^3$) for Reduced Sulfur Compounds Sampled – Site A

Sample Log No.	Sample Date	Hydrogen Sulfide	Carbonyl Sulfide	Methyl Mercaptan	Ethyl Mercaptan	Dimethyl Sulfide	Carbon Disulfide	Isopropyl Mercaptan	tert-Butyl Mercaptan	n-Propyl Mercaptan	Ethyl Methyl Sulfide	Thiophene	Isobutyl Mercaptan	Diethyl Sulfide	n-Butyl Mercaptan	Dimethyl Disulfide	3-Methylthiophene	Tetrahydrothiophene	2-Ethylthiophene	2,5-Dimethylthiophene	Diethyl Disulfide	Total Red. Sulfur (ppb)
S050806A	05/03/06	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
S050906A	05/04/06	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	
S051006A	05/06/06	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
S051106A	05/07/06	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	11	220
S051906A	05/08/06	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
S052006A	05/09/06	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	
S052106A	05/10/06	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
S052206A	05/11/06	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
S052306A	05/12/06	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
no. of sampling days		9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
% valid samples		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
mean conc.		3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	4.16	
st. dev.		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	2.56	
min. conc.		3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	
max. conc.		3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	11.0	
LDL		var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	Var*	var*	var*	var*	var*	
eq 1-hr conc		79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	99.9	

*variable

Table 8.24 Airborne Concentrations (µg/m^3) for Reduced Sulfur Compounds Sampled – Site B

Sample Log No.	Sample Date	Hydrogen Sulfide	Carbonyl Sulfide	Methyl Mercaptan	Ethyl Mercaptan	Dimethyl Sulfide	Carbon Disulfide	Isopropyl Mercaptan	tert-Butyl Mercaptan	n-Propyl Mercaptan	Ethyl Methyl Sulfide	Thiophene	Isobutyl Mercaptan	Diethyl Sulfide	n-Butyl Mercaptan	Dimethyl Disulfide	3-Methylthiophene	Tetrahydrothiophene	2-Ethylthiophene	2,5-Dimethylthiophene	Diethyl Disulfide	Total Red. Sulfur (ppb)
S050806B	05/03/06	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	
S050906B	05/05/06	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	
S051106B	05/07/06	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	58
S051306B	05/10/06	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	
S051406B	05/11/06	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	
S051506B	05/12/06	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	
S051606B	05/13/06	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	
S051706B	05/14/06	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	
S051806B	05/15/06	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	
S051906B	05/16/06	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	
S052006B	05/17/06	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
S052106B	05/18/06	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	
S052206B	05/19/06	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
S052306B	05/20/06	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	
no. of sampling days		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	
% valid samples		86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	86%	
mean conc.		4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	
st. dev.		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
min. conc.		4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	
max. conc.		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
LDL		var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	
eq 1-hr conc		108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	

*variable

Table 8.25 Airborne Concentrations (µg/m^3) for Reduced Sulfur Compounds Sampled – Site C

Sample Log No.	Sample Date	Hydrogen Sulfide	Carbonyl Sulfide	Methyl Mercaptan	Ethyl Mercaptan	Dimethyl Sulfide	Carbon Disulfide	Isopropyl Mercaptan	tert-Butyl Mercaptan	n-Propyl Mercaptan	Ethyl Methyl Sulfide	Thiophene	Isobutyl Mercaptan	Diethyl Sulfide	n-Butyl Mercaptan	Dimethyl Disulfide	3-Methylthiophene	Tetrahydrothiophene	2-Ethylthiophene	2,5-Dimethylthiophene	Diethyl Disulfide	Total Red. Sulfur (ppb)
S050806C	05/03/06	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	
S051006C	05/04/06	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
S051106C	05/05/06	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	
S051206C	05/06/06	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	
S051306C	05/07/06	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
S051406C	05/08/06	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	
S051506C	05/09/06	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	12
S051606C	05/10/06	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
S051706C	05/11/06	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	16
S051806C	05/12/06	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
S051906C	05/13/06	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
S052006C	05/14/06	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
S052106C	05/15/06	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
S052206C	05/16/06	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	
S052306C	05/17/06	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
no. of sampling days		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	
% valid samples		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
mean conc.		3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	
st. dev.		0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	
min. conc.		3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	
max. conc.		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
LDL		var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	var*	
eq 1-hr conc		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	

*variable

Table 8.26 HQs, HIs, and Cancer Risks for Reduced Sulfur Compounds Sampled – Site A

		Hydrogen Sulfide	Carbonyl Sulfide	Methyl Mercaptan	Ethyl Mercaptan	Dimethyl Sulfide	Carbon Disulfide	Isopropyl Mercaptan	tert-Butyl Mercaptan	n-Propyl Mercaptan	Ethyl Methyl Sulfide	Thiophene	Isobutyl Mercaptan	Diethyl Sulfide	n-Butyl Mercaptan	Dimethyl Disulfide	3-Methylthiophene	Tetrahydrothiophene	2-Ethylthiophene	2,5-Dimethylthiophene	Diethyl Disulfide
CRL ($\mu g/m^3$)	**acute**	120	186	50	2500	N/A	40500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HQ	**acute**	0.7	0.4	1.6	0.03	N/A	0.002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total HI	**acute**	3																			
CRL ($\mu g/m^3$)	**chronic**	2	N/A	N/A	N/A	N/A	700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HQ	**chronic**	2	N/A	N/A	N/A	N/A	0.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total HI	**chronic**	2																			
Cancer	**IUR**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cancer per 10^6 population		N/A																			
Total Added Cancer Cases		N/A																			
Target Organs	**Neuro**	1	1	1	1		1		1			1			1						
	Resp												1								
	Liver																				
	Repro																				
	Kidney																				
	Developm																				
	Ocular																				
	Immuno																				

Table 8.27 HQs, HIs, and Cancer Risks for Reduced Sulfur Compounds Sampled – Site B

		Hydrogen Sulfide	Carbonyl Sulfide	Methyl Mercaptan	Ethyl Mercaptan	Dimethyl Sulfide	Carbon Disulfide	Isopropyl Mercaptan	tert-Butyl Mercaptan	n-Propyl Mercaptan	Ethyl Methyl Sulfide	Thiophene	Isobutyl Mercaptan	Diethyl Sulfide	n-Butyl Mercaptan	Dimethyl Disulfide	3-Methylthiophene	Tetrahydrothiophene	2-Ethylthiophene	2,5-Dimethylthiophene	Diethyl Disulfide
CRL ($\mu g/m^3$)	**acute**	120	186	50	2500	N/A	40500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HQ	**acute**	0.9	0.58	2.17	0.04	N/A	2.7E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total HI	**acute**	4																			
CRL ($\mu g/m^3$)	**chronic**	2	N/A	N/A	N/A	N/A	700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HQ	**chronic**	2.26	N/A	N/A	N/A	N/A	0.01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total HI	**chronic**	2																			
Cancer	**IUR**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cancer per 10^6 population		N/A																			
Total Added Cancer Cases		N/A																			
Target Organs	**Neuro**	1	1	1	1		1		1			1			1						
	Resp												1								
	Liver																				
	Repro																				
	Kidney																				
	Developm																				
	Ocular																				
	Immuno																				

Table 8.28 HQs, HIs, and Cancer Risks for Reduced Sulfur Compounds Sampled – Site C

	Sample Date	Hydrogen Sulfide	Carbonyl Sulfide	Methyl Mercaptan	Ethyl Mercaptan	Dimethyl Sulfide	Carbon Disulfide	Isopropyl Mercaptan	tert-Butyl Mercaptan	n-Propyl Mercaptan	Ethyl Methyl Sulfide	Thiophene	Isobutyl Mercaptan	Diethyl Sulfide	n-Butyl Mercaptan	Dimethyl Disulfide	3-Methylthiophene	Tetrahydrothiophene	2-Ethylthiophene	2,5-Dimethylthiophene	Diethyl Disulfide
CRL ($\mu g/m^3$)	**acute**	120	186	50	2500	N/A	40500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HQ	**acute**	0.75	0.48	1.79	0.04	N/A	2.2E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total HI	**acute**	3																			
CRL ($\mu g/m^3$)	**chronic**	2	N/A	N/A	N/A	N/A	700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HQ	**chronic**	1.87	N/A	N/A	N/A	N/A	0.01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total HI	**chronic**	2																			
Cancer	**IUR**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cancer per 10^6 population		N/A																			
Total Added Cancer Cases		N/A																			
Target Organs	**Neuro**	1	1	1	1		1		1			1			1						
	Resp												1								
	Liver																				
	Repro																				
	Kidney																				
	Developm																				
	Ocular																				
	Immuno																				

8.7.2 Site A

The total RSC acute HI is 3 and the total RSC chronic HI is 2. The data indicate there is both a significant acute exposure hazard and chronic exposure hazard. Looking more closely at the acute exposure data, methyl mercaptan (HQ=2) is the risk driver. Recall that the acute HQ was derived by assuming a "worst-case scenario"; the 24-hour average concentration was compressed into an equivalent 1-hour period. If an equivalent 1-hour concentration is considered to be the same as the 24-hour average concentration, then the methyl mercaptan HQ = 0.03. Under this scenario, there appears to be no real acute risk. There are no sampling data available the analysis of which would tend to favor either of these two scenarios, but using professional judgment one may conclude that the latter scenario is closer to reality than the former. As for chronic risk, the sole risk driver is hydrogen sulfide (HQ=1.7), and there does appear to be a chronic exposure risk.

Cancer risk was not determined because there is no evidence that any of the sampled RSCs is carcinogenic.

8.7.3 Site B

The total RSC acute HI is 4 and the total RSC chronic HI is 2, the data indicate there is a significant acute exposure hazard and a significant chronic exposure hazard. The data indicate that methyl mercaptan (HQ=2.2) is the sole risk driver, accounting for virtually approximately 55% of the acute HI. Recall that the acute HQs were derived by assuming a "worst-case scenario;" the 24-hour average concentration was compressed into an equivalent 1-hour period. If an equivalent 1-hour concentration is considered to be the same as the 24-hour average concentration, then the methyl mercaptan HQ is 0.1. There are no sampling data available the analysis of which would tend to favor either of these two scenarios, but using professional judgment one may conclude that the latter scenario is closer to reality than the former. There does not appear to be acute risk resulting from exposure at the Blue Ridge site. The chronic HI is 2, with hydrogen sulfide contributing virtually 100% of the HI.

Cancer risk was not determined because there is no evidence that any of the sampled RSCs is carcinogenic.

8.7.4 Site C

The total RSC acute HI is 3 and the total RSC chronic HI is 2; the data indicate there is both an acute exposure hazard and a chronic exposure hazard. Looking more closely at the acute exposure data, it is evident that methyl mercaptan (HQ=1.8) is the risk driver, accounting for approximately 94% of the acute HI. Recall that the acute HQs were derived by assuming a "worst-case scenario;" the 24-hour average concentration was compressed into an equivalent 1-hour period. If an equivalent 1-hour concentration is considered to be the same as the 24-hour average concentration, then the HQ for methyl mercaptan would become 0.03. Under this scenario, the acute HI is much less than 1; there does not appear to be any elevated risk due to acute exposure. There are no sampling data available the analysis of which would tend to favor either of these two scenarios, but using professional judgment one may conclude that the latter scenario is closer to reality than the former. The chronic HI is 2, with hydrogen sulfide contributing virtually 100%.

Cancer risk was not determined because there is no evidence that any of the sampled RSCs is carcinogenic.

8.8 Target Organ Specific Hazard Index (TOSHI)

As explained in Section 8.2, if a Hazard Index exceeds 1, that HI must be examined more critically, emphasizing the organs or organ systems affected by the chemical compounds sampled. In this evaluation, the exposure effects on the following target organs or organ systems were evaluated: neurological, respiratory, liver, reproductive, kidney, developmental, ocular, and immunological.

The TOSHI for Site A indicates that the target organ system maximally impacted is neurological system (see Table 8.29). Reduced sulfur compound exposure is the driver. For Site B, the target organ systems maximally impacted are neurological (RSCs) and respiratory systems (carbonyl compounds). For Site C, there is no specific target organ system affected by exposure.

Table 8.29 TOSHI Summary

		Chronic Exposure			
Site A		**VOCs**	**Carbonyls**	**RSCs**	**Total**
	Neuro	0.01		**1.66**	**1.67**
	Resp	0.003	0.73		**0.73**
	Liver	0.11	4.91E-05		**0.11**
	Repro	3.50E-04			**3.5E-04**
	Kidney	1.16E-03	4.91E-05		**1.2E-03**
	Developm	0.001			**1.4E-03**
	Ocular	0.04			**0.04**
	Immuno				
	TOTAL	**0.16**	**0.73**	**1.66**	
Site B					
	Neuro	0.01		**2.3**	**2.27**
	Resp	7.30E-04	**3.2**		**3.20**
	Liver	0.01	3.80E-05		**0.01**
	Repro	0.11			**0.11**
	Kidney	3.50E-04	3.80E-05		**3.9E-04**
	Developm	5.90E-04			**5.9E-04**
	Ocular	1.14E-03			**1.1E-03**
	Immuno	0.04			**0.04**
	TOTAL	**0.17**	**3.20**	**2.26**	
Site C					
	Neuro	0.01		0.01	**0.02**
	Resp	7.90E-04	0.51		**0.51**
	Liver	0.02	5.40E-05		**0.02**
	Repro	0.11			**0.11**
	Kidney	2.10E-04	5.40E-05		**2.6E-04**
	Developm	8.50E-04			**8.5E-04**
	Ocular	0.001			**1.0E-03**
	Immuno	0.04			**0.04**
	TOTAL	**0.18**	**0.51**	**0.01**	

APPENDIX A

Technical Project Plan for Canton Odor Complaint Investigation

TECHNICAL PROJECT PLAN

For the

North Carolina
Department of Environment & Natural Resources
Division of Air Quality
Toxics Protection Branch

Canton Odor Complaint Investigation

ATAST Investigation Number: 06011

Lori Cherry, Project Administrator	Date
Jim Bowyer, Project Manager	Date
Richard Lasater, Study Manager	Date
Quality Assurance Manager	Date

Technical Project Plan

Preface

This document serves as the Technical Project Plan for the Canton Ambient Air Quality Monitoring Study. This plan describes all the dimensions involved in the overall project, including the nearby emission sources, ambient monitoring methods, quality assurance practices, and data analysis and reporting procedures. The project is comprised of field sampling operations and the ensuing chemical analysis of these samples, meteorological data collection, and related project data collection, management, and reporting.

Due to the nature of this study, this project plan may need to be revised as the study progresses. The Project Manager in conjunction with the Project Administrator and Study Manager will initial, date, and concurrently incorporate any changes into all copies of the document.

Table of Contents

Acronyms

AQL - Air Quality Laboratory of the Toxics Protection Branch
ATAST - Air Toxics Analytical Support Team
COC - Chain of Custody
DAQ - Division of Air Quality
EPA - Environmental Protection Agency
QA/QC - Quality Assurance/Quality Control
QAM - Quality Assurance Manager
RSC – Reduced Sulfur Compounds
SOP - Standard Operating Procedures
TPB – Toxics Protection Branch
VOC - Volatile Organic Compounds

Distribution List

L. Cherry, NCDAQ, Toxics Protection Branch
P. Muller, NCDAQ, Asheville Regional Office Supervisor
B. Davet, NCDAQ, Asheville Regional Office
P. Dickens, Blue Ridge Paper Products

1. Project Overview

This document serves as the Technical Project Plan for the Canton Odor Complaint Study. The objective of the effort to be performed by the NC Division of Air Quality is to monitor ambient concentrations of volatile organic compounds, reduced sulfur compounds (including hydrogen sulfide), mercury and speciated mercury, ammonia, and carbonyl compounds during May 2006 during a facility maintenance shutdown.

The intent of this project plan is to describe each part of the study and to describe how the parts will be integrated into the overall project. The document describes the:

- Emission sources under investigation,
- Ambient monitoring, and
- Quality assurance and quality control activities

1.1 Background

Blue Ridge Paper Products, formerly Champion International, has operated a pulp and paper mill at Canton, NC since 1905. In November 2005, in response to numerous documented odor complaints received from Canton citizens concerning the Blue Ridge Paper Products facility (18 in 2004, 36 in 2005 and 9 to date in 2006), the NCDAQ Asheville Regional Office (ARO) requested that the Toxics Protection Branch conduct an ATAST Investigation at Canton, NC to qualify and quantify odorous compound emissions.

On December 8, 2005, Ms. Lori Cherry, Dr. Jim Bowyer, and Mr. Richard Lasater from NCDAQ TPB, ARO personnel, NCASI (National Council for Air and Stream Improvement) and Blue Ridge Paper (BRPP) personnel met at Canton, NC to discuss the ATAST investigation. BRPP discussed an in-house odorous emission survey conducted at the mill in 2005 which determined that majority of odorous emissions were emitted from the mill's wastewater collection sewer. The main emission point was the wet well from which the sewage was pumped across the Pigeon River to the plant's wastewater treatment plant.

The majority of odorous compounds present in the collected mill sewage are normally reduced by 95 to 99% by means of a steam stripper prior to treatment in the wastewater treatment plant. The stripper off-gas is then burned in the limekilns. BRPP stated that an annual maintenance downtime for the steam stripper was scheduled for May 15, 2006 during which no sewage stripping would be occuring. Planned outage for inspection is a minimum of four (4) days. To minimize the potential for odorous emissions from the wastewater treatment system during this outage, BRPP also plans inspection outages for the pine fiber line (digesters, washers and associated systems) and one of the plant's two pulping chemical recovery furnaces. This is expected to reduce the total amount of unstripped foul condensate going to the wastewater treatment plant by 50 to 60%.

It was decided to conduct the ATAST Investigation monitoring before, during, and after the stripper, pine fiber line, and recovery furnace downtime. This would cover the time of maximum exposure to the local population from the actual maintenance downtime as well as system purging prior to shutdown and excess emissions during startup. BRPP has an activated sludge municipal-type wastewater treatment plant (WWTP) rather than the more typical 30 to 60 day retention lagoons due to space limitations. This type of WWTP is very susceptible to negative effects from sudden increases of incoming chemical loading. In 2005, the WWTP was knocked out during the steam stripper downtime. As the mill will continue to operate, even on reduced production, possible drastic reduction of the WWTP's biological odorous compound reduction potential could result in increased emissions of odorous compounds (such as ammonia).

2. Description of Nearby Industry

Dominating the local environment is the Blue Ridge Paper (BRPP) pulp and paper mill. This mill has operated continuously at this location since 1903 under various company names. The Town of Canton literally surrounds the BRPP. The main odor complainant lives due East of the BRPP mill, next to the BRPP employees parking lot. Two small industries, a lamp factory and a custom wood furniture shop, are located in the immediate area. The rest of the area consists of residences, apartment houses, churches and service industries such as fast food restaurants.

1.1 Blue Ridge Paper Products

1.1.1 Facility Description

The Blue Ridge Paper Products facility is a large integrated bleached Kraft process pulp and paper mill. There are separate pine and hardwood pulp fiber production lines. Each fiber line includes batch digesters, washers and oxygen delignification systems. There are two pulping chemical recovery furnaces with associated pulping liquid evaporators and two lime kilns to recycle pulping chemicals. Separate hardwood and pine pulp bleach lines and a chlorine dioxide generation plant comprise the Bleaching Area. Four coal-fired boilers and a woodwaste/bark/coal-fired bark boiler provide process steam.

Purchased wood chips are cooked with Kraft process pulping chemicals such as sodium hydroxide and sodium sulfide in batches inside steam heated pressure cookers or digesters to loosen and separate the cellulose fibers. The fibers are then washed to remove the pulping chemicals. The resulting brown wood pulp is treated with oxygen to lighten its color and finally bleached to white paper pulp in the Bleaching Area. The bleached pine and hardwood pulps are then made into paper on three paper machines.

2.1.2 Description of Emissions and Process Description

Odorous emissions from this facility are reduced sulfur compounds (including hydrogen sulfide, dimethyl disulfide, dimethyl sulfide, and methyl mercaptan), acetaldehyde, creosol, formaldehyde, hydrogen chloride, ammonia and sulfuric acid.

The majority of the reduced sulfur compounds are emitted from the pulp production and chemical recovery systems and the mill’s wastewater treatment system. The organic compounds, sulfuric acid and hydrochloric acid are emitted from coal and woodwaste combustion in the power boilers and from combustion of pulping residue in the chemical recovery furnaces. The boilers and furnaces are equipped with electrostatic precipitators for particulate reduction. There are foul gases and foul condensate collection systems installed on the pulp production systems to reduce emissions of hazardous air pollutants. Collected foul gases are passed thru condensers to remove moisture and the burned in the lime kilns. Foul condensate is collected and steam stripped prior to discharge to the wastewater treatment plant. Stripper offgas is ducted to the lime kilns for burning.

The wastewater treatment plant at Blue Ridge Paper Products is an activated sludge type like a municipal sewer treatment plant rather than the large area treatment lagoons used at other North Carolina pulp and paper mills because of limited space.

An internal study conducted by BRPP on odorous emissions indicated that the major sources were the wastewater collection system wet wells and manholes.

On May 15, 2006, annual maintenance requires BRPP to shut down the foul condensate steam stripper for inspection. During the estimated four (4) day inspection period, all collected foul condensate from the hardwood pulp production and associated recovery furnace will be discharged directly into the wastewater treatment system. To minimize the amount of foul condensate produced during this period, the pine fiber line and associated recovery furnace will be shut down. This will be an approximately 40 % reduction in overall pulp production. This study is planned to begin monitoring on May 1, 2006 before the steam stripper outage and continue thru May 24, 2006. This will allow comparison of normal mill operation before and after the stripper outage.

An industrial activated sludge type of wastewater treatment plant can be adversely affected by an inlet chemical concentration increase such as will result when the steam stripper is not operated to remove those compounds for combustion. Purging of the pine fiber line during shutdown and a gradual increase in volume of unstripped condensate sent to the wastewater system will be done to minimize overload.

3.0 Ambient Air Monitoring

3.1 Ambient Monitoring Schedule: Monitoring will be conducted for a 3-week period beginning on May 8, 2006. This will include the week before the planned shutdown, the week during the shutdown, and the week after the shutdown. Air monitoring equipment will be setup, tested, and/or calibrated beginning approximately 1 week prior to the May 8th start date. All non-continuous samplers will collect samples from 9am to 9am each day. As the equipment becomes functional data will be collected.

3.2 Air Sampling Sites and Instrumentation: There are three sampling sites for this study. (See maps for locations of sites.) Site A is located on the campus of Asheville Buncombe Technical Community College (AB Tech). This site is also an Urban Air Toxics Network Site. This site is approximately 25 miles from Canton, NC and will serve as a non-impacted site.

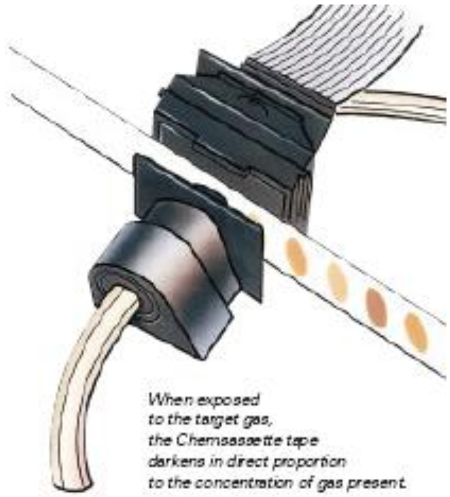
BRPP operates its own meteorological tower and was asked to provide an annual wind rose for Canton. The wind rose showed that the primary wind directions were due east (towards the complainant's house) and east-southeast. From this data and the record of odor complaints, it was desirable to have two test sites in Canton. Site B is located in a former air monitoring building in a BRPP employee parking lot east of the plant, between the plant and the site of the majority of the odor complaints. Site C is located in a rarely used BRPP employee/municipal parking lot in downtown Canton, approximately ¼ mile from Site B and across the railroad tracks from the plant in an east-southeast direction from the WWTP and wet well. At site C there will be a mobile laboratory trailer to provide on-site carbonyl analysis and a motor home (used as on site office space).

There are two small industries located east of BRPP across the railroad tracks from the complainant site. One is Arrow Wood Products, a custom wood products shop and the other is Coastal Lamp Manufacturing, Inc. Both have very minor emissions (less than 100 pounds of coating solvents per month).

Each site will be equipped as follows:

***3.2.1 Meteorological Station (continuous monitoring)**:* Meteorological data will be collected to support the study. A 10-meter meteorological tower will be installed at all three air monitoring locations. 10 meters is the height at which standard meteorological conditions are measured. Wind speed, wind direction, temperature, barometric pressure, and relative humidity will be measured at each site. Meteorological data will be averaged for on a 5 minute basis.

3.2.2 Ammonia (continuous monitoring): Ammonia (NH_3) will be monitored using a Honeywell (Zellweger) MDA Single Point Monitor (SPM). The SPM employs a specially treated paper tape specific for ammonia and an LED optical sensor that monitors color development. Quantification is based the degree of color change. These measurements will be continuously datalogged and downloaded daily for data analysis.



3.2.3 Carbonyls (24 hr time-integrated): A carbonyl is defined as a compound composed of hydrogen, carbon, and oxygen with at least 1 carbon-oxygen double bond typically aldehydes and ketones. Carbonyls may be emitted from industrial sources or formed (or removed) in the atmosphere. For example, hydrocarbons may interact with nitrogen oxides and sunlight to produce carbonyls which are intermediates in the production of ozone. The EPA method TO-11a will be used for the determination of carbonyls.

Ambient air is sampled for 24 hours at 1 liter per minute through a silica cartridge coated with dinitrophenylhydrazine (DNPH) using an ATEC carbonyl sampler (Models 100 and 2200). The cartridges will be immediately taken from the sites to the mobile laboratory in Canton for extraction and analysis on site. Extracts of the hydrazone derivatives will be analyzed using a Dionex HPLC with Ultraviolet (UV) detection.

Carbonyl Compounds

Formaldehyde	*Hexaldehyde*
Acetaldehyde	*Crotonaldehyde*
Propionaldeyde	*Valeraldehyde*
Benzaldehyde	*Tolualdehydes*
Butyraldeyde	*Isovaleraldehyde*

3.2.4 Volatile Organic Compounds (VOC) (24 hr time-integrated): EPA method TO-15 will be used for the determination of VOCs. Analytes include hydrocarbons, halogenated hydrocarbons, and polar compounds. Ambient air is sampled for 24 hours at approximately 10 cc per minute into an evacuated 6-liter "SUMMA" canister using a Xontech 911 pumping system. The canisters will be transported using chain of custody (COC) procedures to the Division of Air Quality Laboratory in Raleigh, NC for analysis. The samples will be analyzed using a Varian Saturn Gas Chromatograph Mass Spectrometer (GC/MS) equipped with an Entech cryogenic preconcentrator.

Volatile Organic Compounds

Acetone	*Ethanol*
Benzene	*Ethyl Acetate*
Benzyl chloride	*Ethylbenzene*
Bromoform	*1-Ethyl-4-methyl Benzene*
Bromomethane	*Heptane*
1,3-Butadiene	*Hexachloro-1,3-Butadiene*
Carbon Disulfide	*Hexane*
Carbon Tetrachloride	*2-Propanol*
Chlorobenzene	*Methyl Ethyl Ketone*
Chloroethane	*Methyl Butyl Ketone*
Chloroform	*Methyl Isobutyl Ketone*
Chloromethane	*Methyl tert-Butyl Ether*
Cyclohexane	*Styrene*
Dibromochloromethane	*Toluene*
1,2-Dibromoethane	*1,1,2,2-Tetrachloroethane*
m-Dichlorobenzene	*Tetrachloroethylene*
o-Dichlorobenzene	*Tetrahydrofuran*
p-Dichlorobenzene	*1,2,4-Trichlorobenzene*
1,1-Dichloroethane	*1,1,1-Trichloroethane*
1,2-Dichloroethane	*1,1,2-Trichloroethane*
1,1-Dichloroethene	*Trichloroethylene*
cis-1,2-Dichloroethene	*Freon-11*
trans-1,2-Dichloroethene	*Freon-113*
Dichloromethane	*1,2,4-Trimethylbenzene*
1,2-Dichloropropane	*1,3,5-Trimethylbenzene*
cis-1,3-Dichloropropene	*Vinyl Acetate*
trans-1,3-Dichloropropene	*Vinyl Chloride*
Freon-12	*m-,p-Xylene*
Freon-114	*o-Xylene*
1,4-Dioxane	

3.2.5 Reduced Sulfur Compounds (RSC) (24 hr time-integrated sample):

These samples will be collected over a 24 hour period using a restricted orifice passive sampler into specially coated 6-liter canisters (SilcoSteel^{TM}) from Restek. The samples will be collected daily and immediately shipped overnight using COC procedures to a commercial lab, Air Toxics Limited, in Folsom, CA. This laboratory will perform the analysis using a gas chromatograph with sulfur chemiluminescence detection (GC-SCD) using ASTM method D-5504. They will also clean and certify that the canisters are clean for reuse.

Reduced Sulfur Compounds

Hydrogen sulfide	*Carbonyl sulfide*
Methyl mercaptan	*Dimethyl sulfide*
Carbon disulfide	*Dimethyl disulfide*
Ethyl mercaptan	*Isopropyl mercaptan*
t-Butyl mercaptan	*n-Propyl mercaptan*
Ethylmethyl sulfide	*Thiophene*
Isobutyl mercaptan	*Diethyl sulfide*
n-Butyl Mercaptan	*3-Methylthiophene*
Tetrahydrothiophene	*2-Ethylthiophene*
2,5-Dimethylthiophene	

3.2.6 Mercury (continuous monitoring): Mercury monitoring will be carried out for elemental, speciated, and particulate mercury using Tekran Models 2537A - Mercury Vapor Analyzer, 1130 - Mercury Speciation Unit, and Model 1135 - Particulate Mercury Unit, respectively at Site C. At sites A and B there will only be an elemental mercury monitoring with a Tekran model 2537A.

Tekran Model 2537A

Tekran Model 1135

Tekran Model 1130

4. Quality Assurance/Quality Control Activities

All sampling media and samples will be placed under Chain of Custody protocols established by the DAQ's Toxics Protection Branch laboratory for transport to and from the site locations and to subsequent laboratory facilities. Electronic site logbooks will be kept on individual computers and transmitted daily to the TPB supervisor via the administrative assistant and saved on servers maintained by the DAQ's information technology group. Downloaded data files will be kept on secure computer(s) and computer media at the mobile lab or mobile office (Itasca motor home).

Duplicates and blanks will be performed as a part of the carbonyl sampling. For the VOC and RSC samples, blanks are not necessary because the sampling canisters are evacuated and not opened until used. Additionally, these canisters are certified as clean before use as is the vacuum pressure. Duplicates for the VOC and RSC samples will be performed if samplers are available for use. Alternatively, during the initial start up of the sites, the duplicate instruments will be run at the same time to obtain duplicate samples. The continuous monitors will be calibrated before deployment and will have intermittent checks made for proper operation to ensure the calibration is still valid, thus duplicates and blanks are not an issue for these monitors. The sampling systems that take discrete 24hr samples will be checked for sample flow rates that are within operating parameters and these values noted. Corrective action will be taken if they are not within the operating parameter before samples are collected with these samplers.

Site security is provided at Sites A and B by an 8 ft chain link fence with chains and locks to control access. At all sites instrumentation that does not require being outside is house in locked sampling buildings/trailer.

APPENDIX B

Photos of Study Sites A, B, and C

Site A Asheville Buncombe Technical Community College

Site B BRPP Employees' Parking

Site B BRPP Employees' Parking

Site B BRPP Employees' Parking

Site C BRPP Employees' / Municipal Parking Lot

Site C BRPP Employees' / Municipal Parking Lot